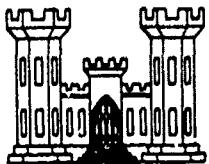
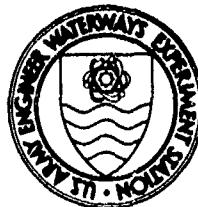


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NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR

Report 4

TIDAL CIRCULATION VELOCITY PATTERNS FOR EXISTING
CONDITIONS AND ALTERNATE MASTER PLAN PIER-J
CONFIGURATIONS WITH -82-FT CHANNEL

by

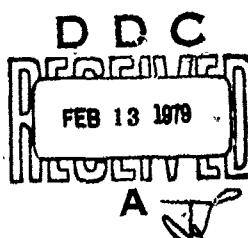
Donald C. Raney

Hydraulics Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

May 1976

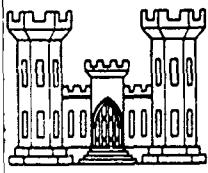
Report 4 of a Series

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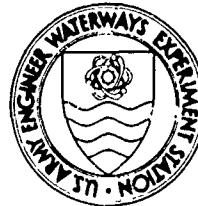


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Long Beach, California 90801

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6 NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR.

Report 4.

TIDAL CIRCULATION VELOCITY PATTERNS FOR EXISTING CONDITIONS AND ALTERNATE MASTER PLAN PIER-J CONFIGURATIONS WITH -82-FT CHANNEL.

by

10 Donald C. Raney

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U. S. Army Engineer Waterways Experiment Station
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11 May 76
Report 4 of a Series

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NUMERICAL ANALYSIS OF TIDAL CIRCULATION FOR LONG BEACH HARBOR

TIDAL CIRCULATION VELOCITY PATTERNS FOR EXISTING CONDITION MASTER PLAN PIER-J CONFIGURATIONS WITH -82-FT CHANNEL

PREFACE

This study was conducted at the U. S. Army Engineer Waterways Experiment Station (WES) with funding provided by the Port of Long Beach, Long Beach, California, under WES Agreement No. 76-8. The study was conducted during the period from November 1975 to April 1976 in the Harbor Wave Action Branch, Wave Dynamics Division, Hydraulics Laboratory, WES, under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, Dr. R. W. Whalin, Chief of the Wave Dynamics Division, and Mr. C. E. Chatham, Chief of the Harbor Wave Action Branch.

The study was conducted and this report prepared by Dr. Donald C. Raney, Associate Professor of Engineering Mechanics at the University of Alabama, assigned to WES under an Intergovernmental Personnel Exchange Agreement. Messrs. H. Lee Butler, K. A. Turner, C. W. Coe, L. A. Barnes, and C. R. Curren assisted with various tasks during the investigation.

A significant portion of the numerical computations associated with this study was performed on a CDC-7600 computer at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico, through the cooperation of C-Division.

The following Port of Long Beach personnel visited WES for conferences associated with the study: Mr. B. N. Hoffmaster, Dr. D. B. Bright, Mr. C. T. Johnson, and Mr. G. H. Porter.

The Director of WES during the course of this study was COL G. H. Hilt, CE. Technical Director was Mr F. R. Brown.

INTRODUCTION

A study was conducted for Long Beach Harbor to numerically investigate tidal circulation in existing basins and to define and evaluate the impact of possible modification of Pier-J with a -82-ft entrance channel on existing harbor circulation. A two-dimensional depth-averaged formulation of the hydrodynamic equations was used in the model and an implicit-explicit finite difference scheme was used to numerically solve the equations. The numerical model was verified using prototype tide and velocity data and tide and velocity data from physical model tests conducted at WES.)

Details of the numerical investigation are presented in Reports 1 and 3 of this series. This report presents vector plots of the tidal circulation patterns at four times during the tidal cycle for existing conditions and for four modifications to Pier-J. In addition, tidal circulation patterns for each modification are compared with circulation patterns for existing conditions. Vector plots are presented indicating the extent and magnitude of velocity changes produced by each modification. In both sets of vector plots the direction of the vector indicates the direction of current flow and the length indicates the magnitude of the current velocity. The four vector plots of tidal circulation pattern for each Pier-J configuration correspond to flow conditions near:

- a. Near slack water (hour 15),
- b. Near maximum flood (hour 19),
- c. Near slack water (hour 22); and
- d. Near maximum ebb (hour 24).

ULATION FOR LONG BEACH HARBOR

FOR EXISTING CONDITIONS AND ALTERNATE RATIONS WITH -82-Ft CHANNEL

RODUCTION

for Long Beach Harbor to numerically model existing basins and to define and possible modification of Pier-J with a -82-ft channel to existing harbor circulation. A two-dimensional formulation of the hydrodynamic model and an implicit-explicit finite difference method is used to numerically solve the equations. The model is calibrated using prototype tide and velocity data obtained from physical model tests conducted at

al investigation are presented in Reports. This report presents vector plots of the tidal currents during the tidal cycle for existing modifications to Pier-J. In addition, tidal current modification are compared with existing conditions. Vector plots are used to show the extent and magnitude of velocity changes in the circulation. In both sets of vector plots the direction of current flow and magnitude of the current velocity. The four vector plots for each Pier-J configuration are shown:

(hour 15),
od (hour 19),
hour 22); and
b (hour 24).

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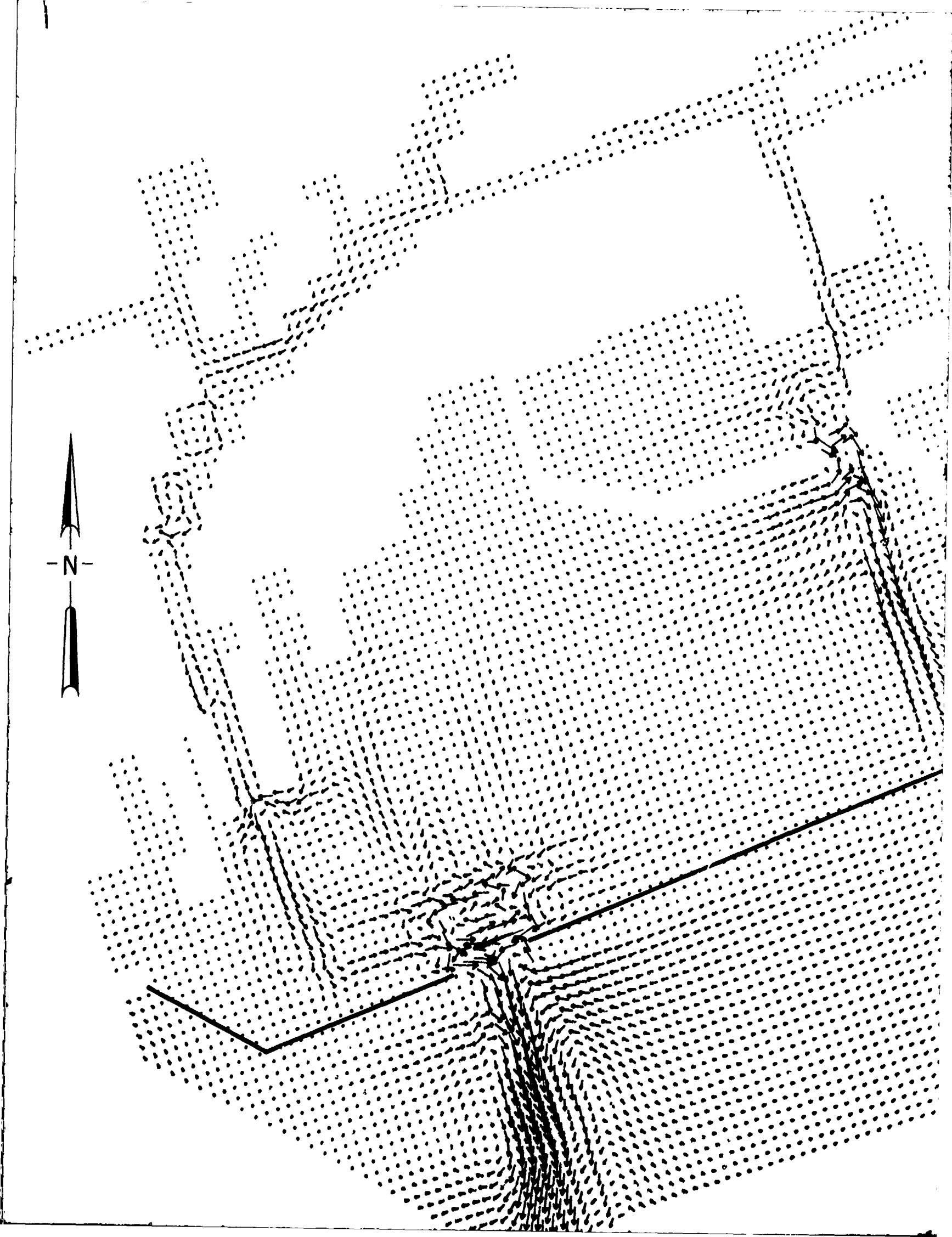
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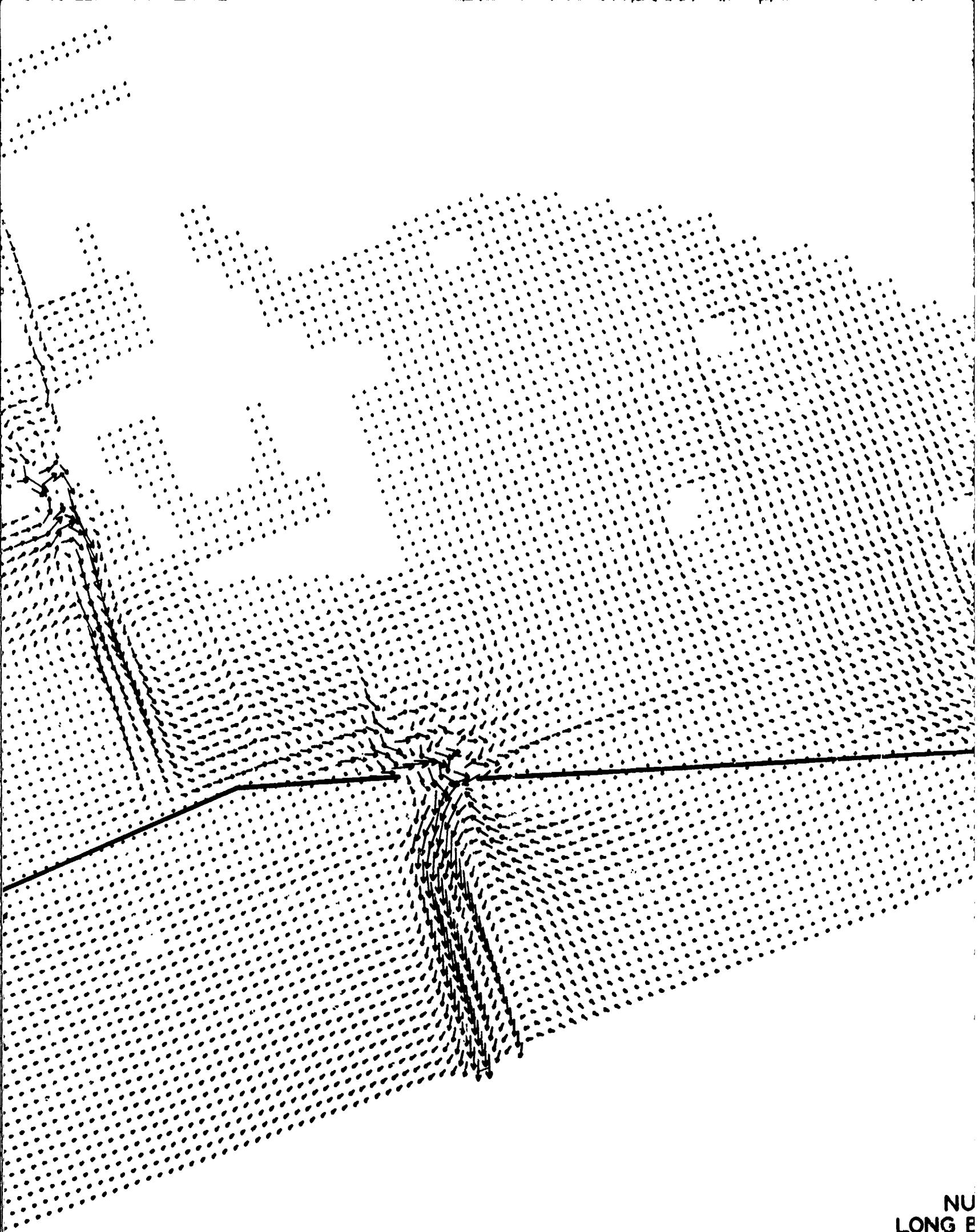
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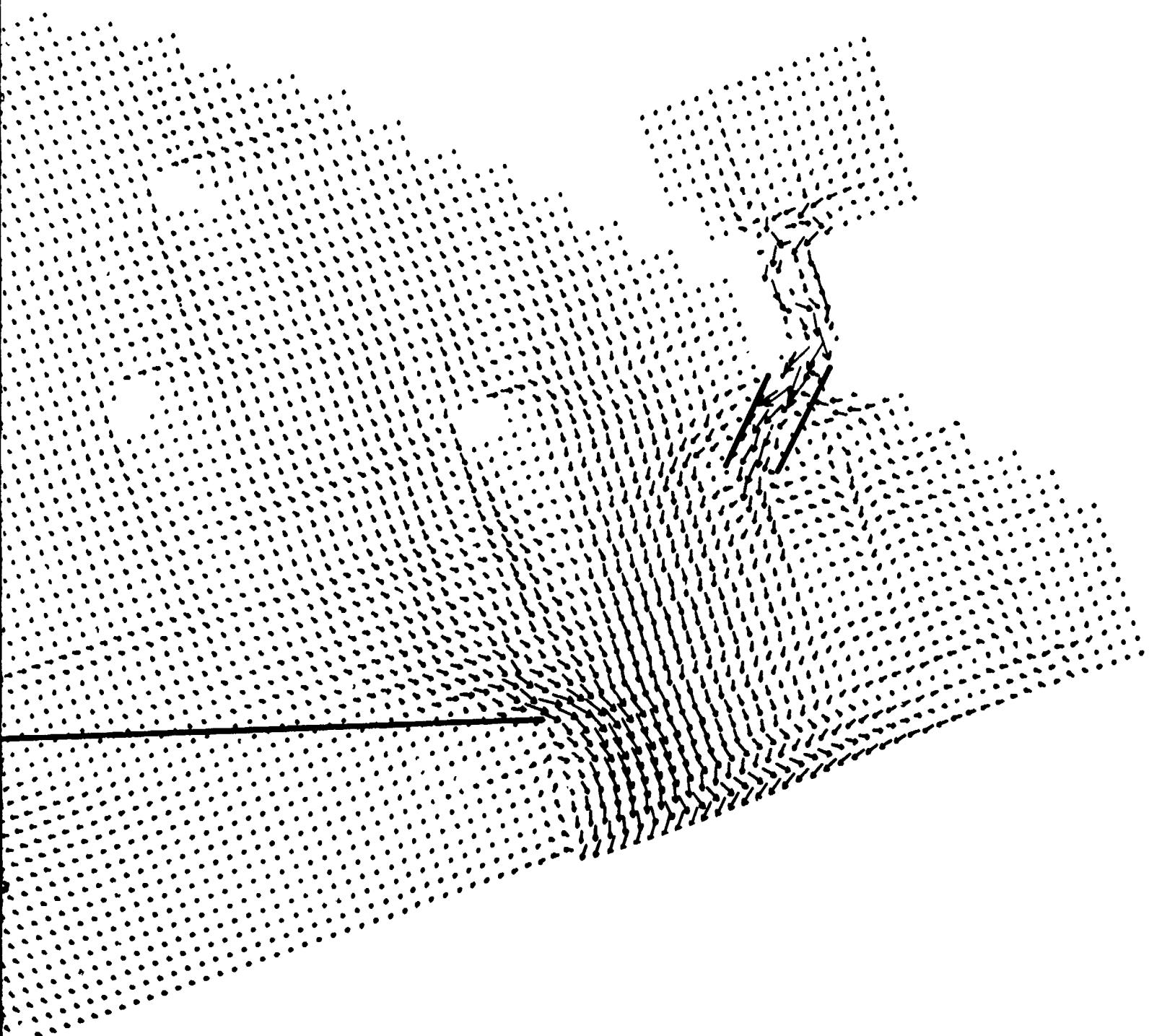
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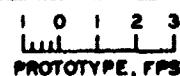




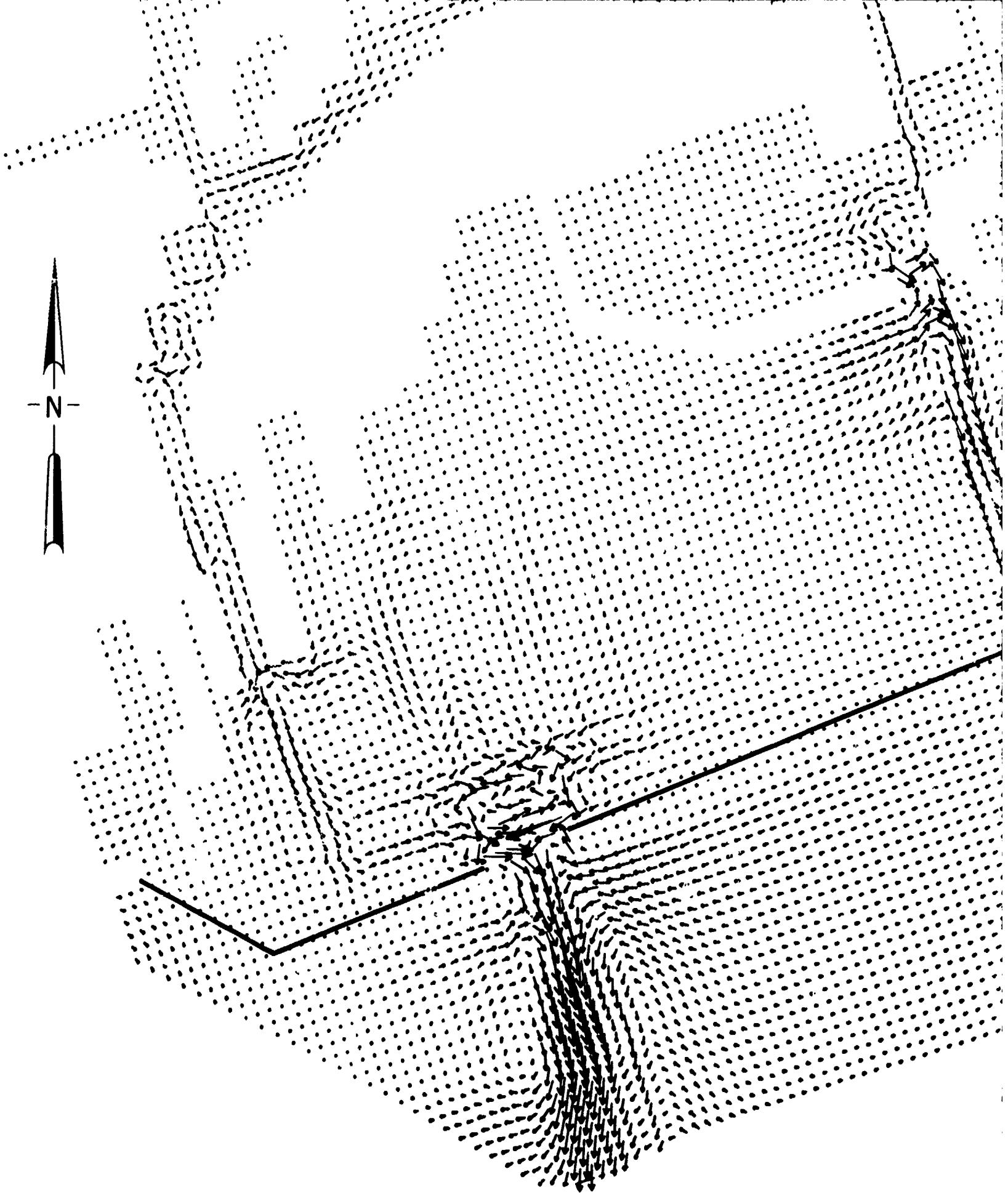
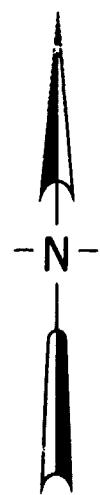
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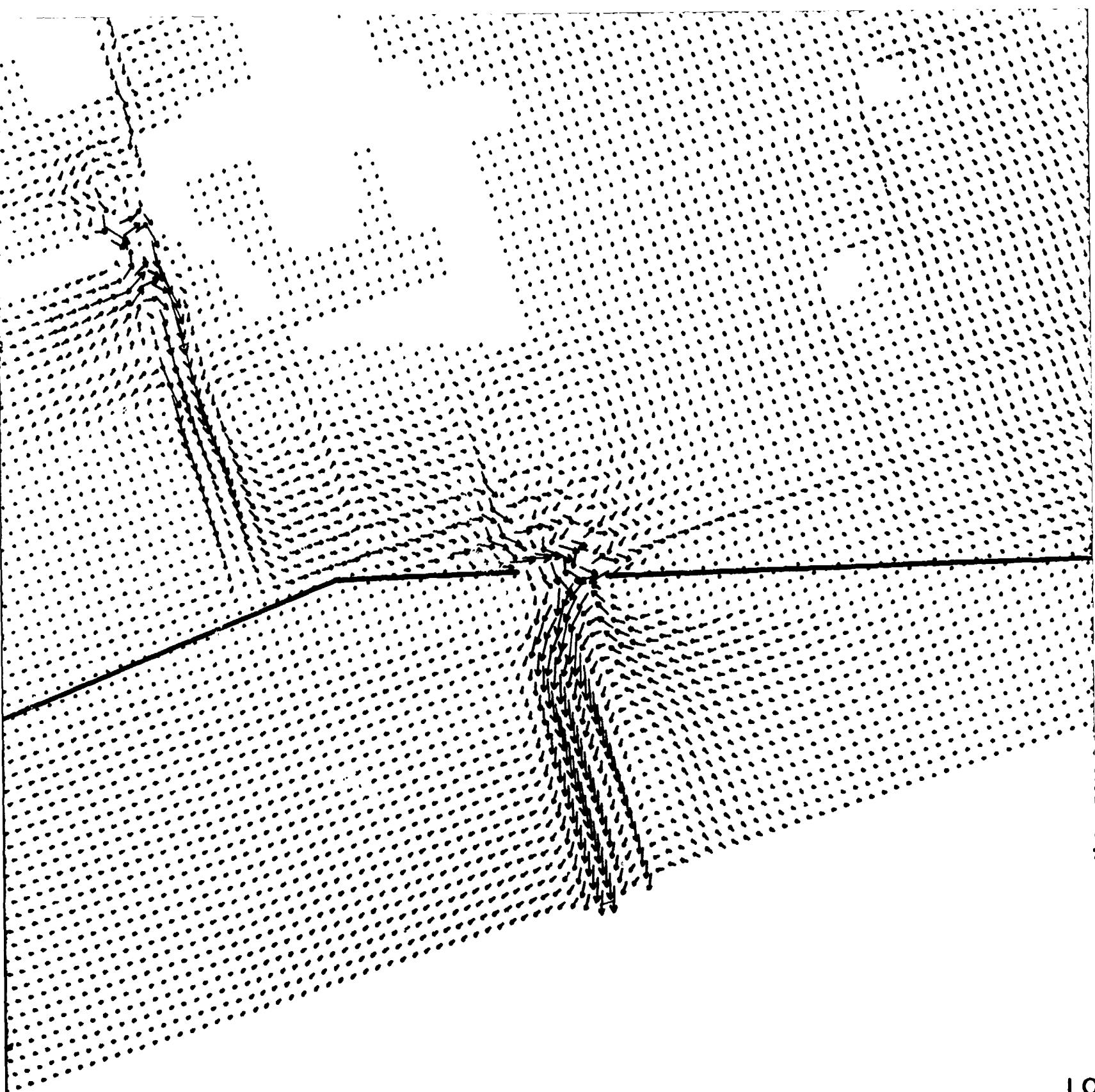
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



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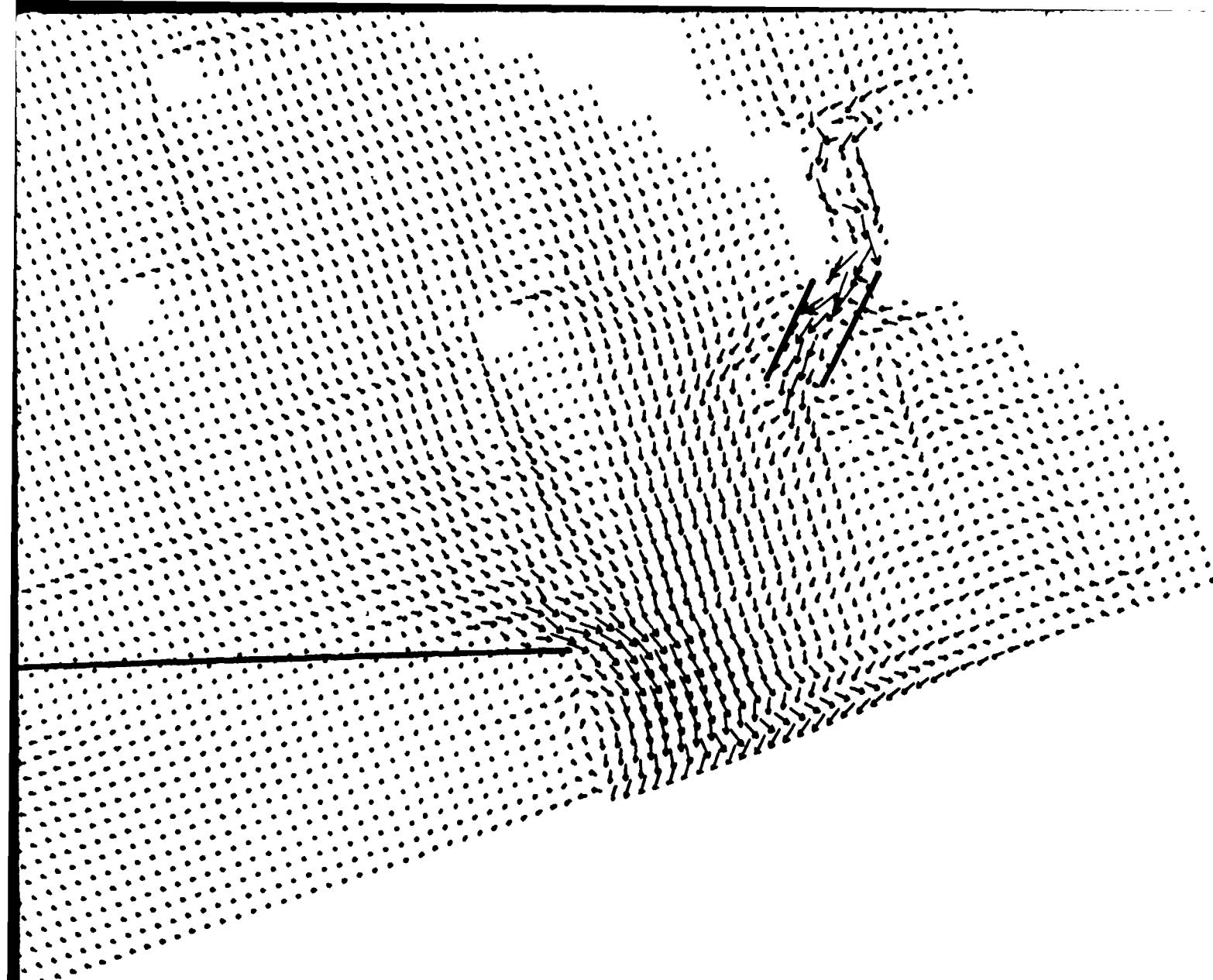
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SCALE IN FEET

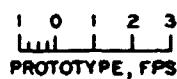
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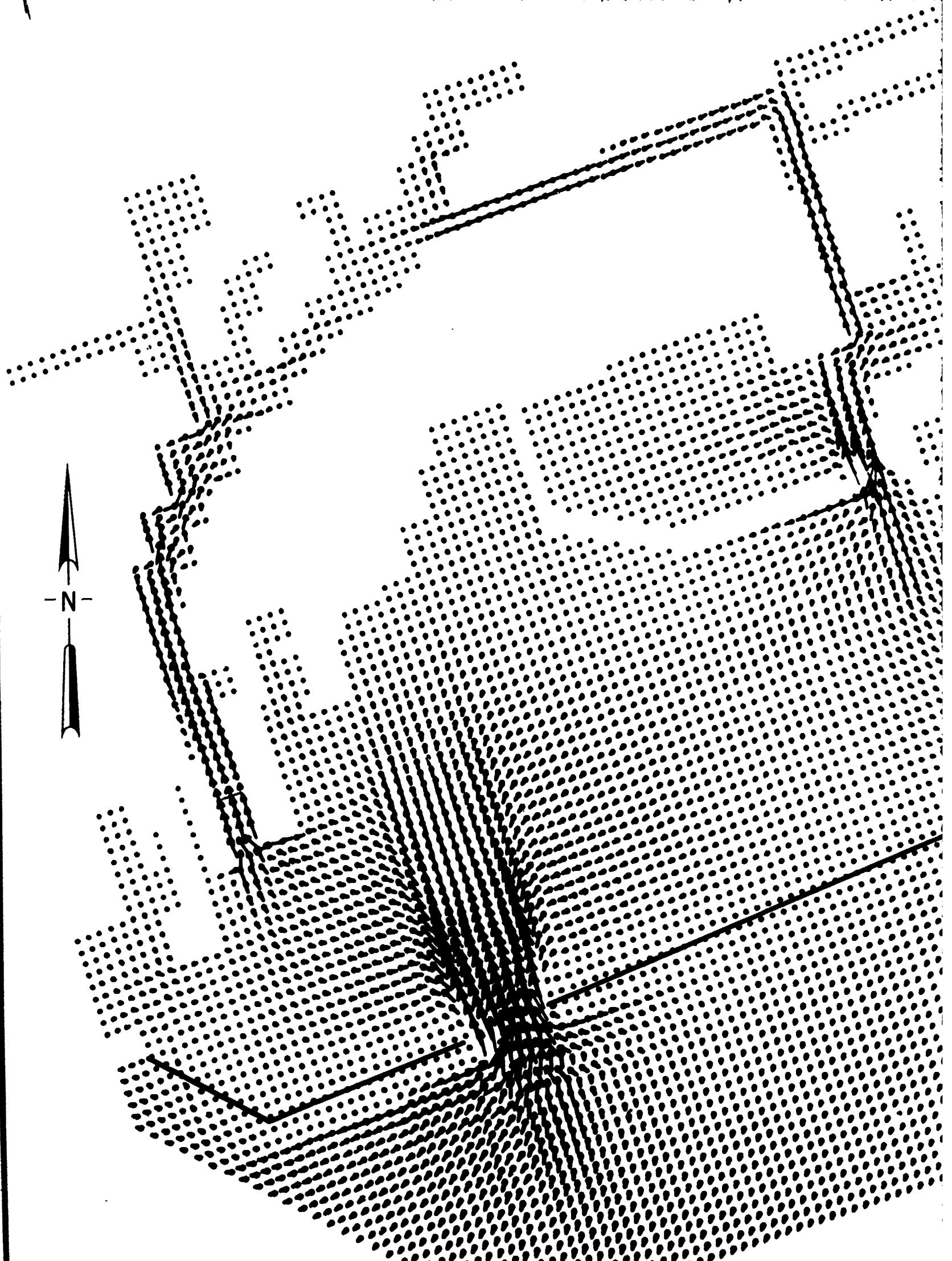
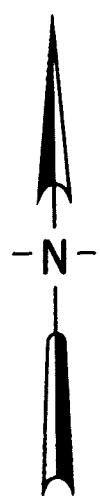
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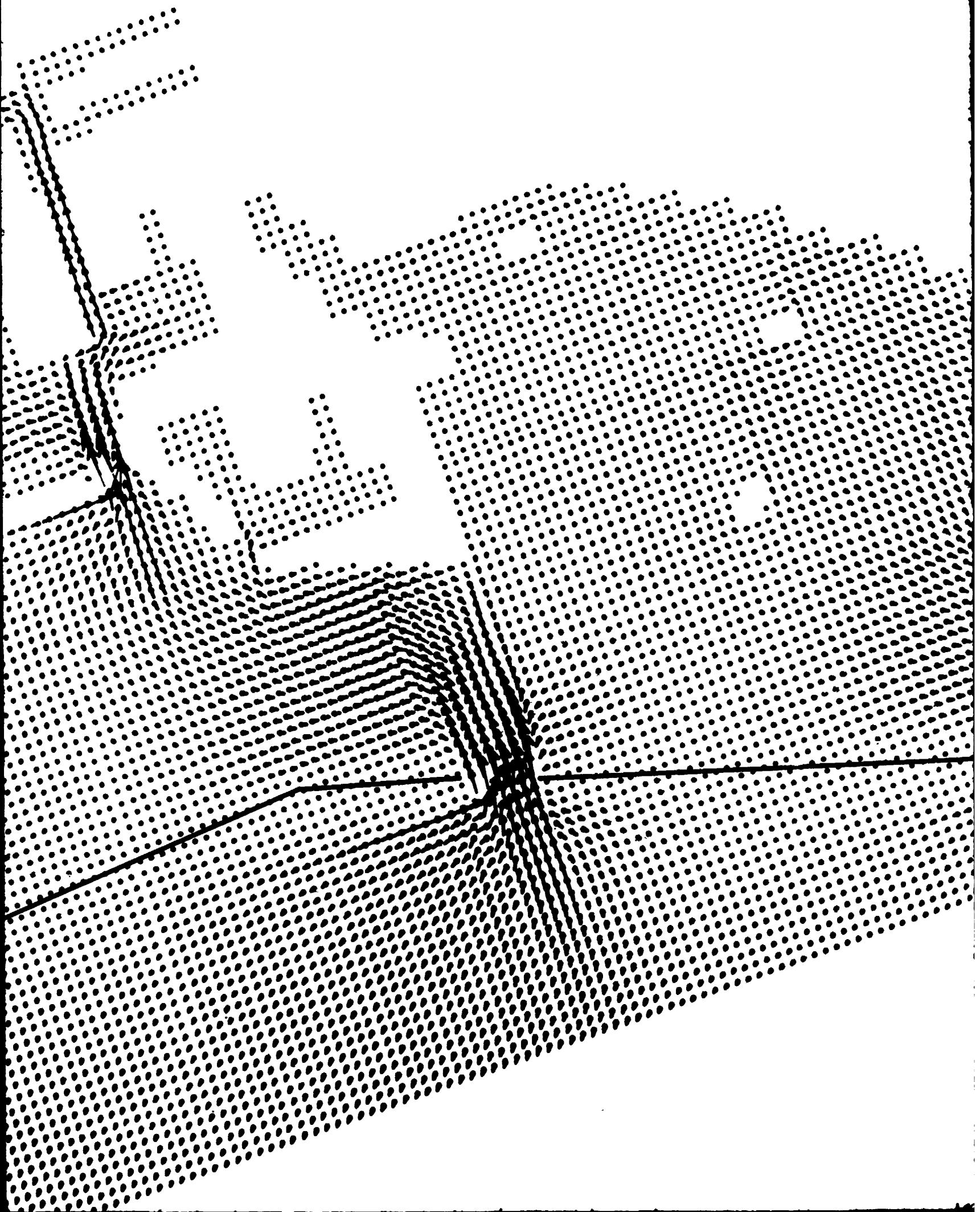
NUMERICAL MODEL STUDY OF
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SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 15



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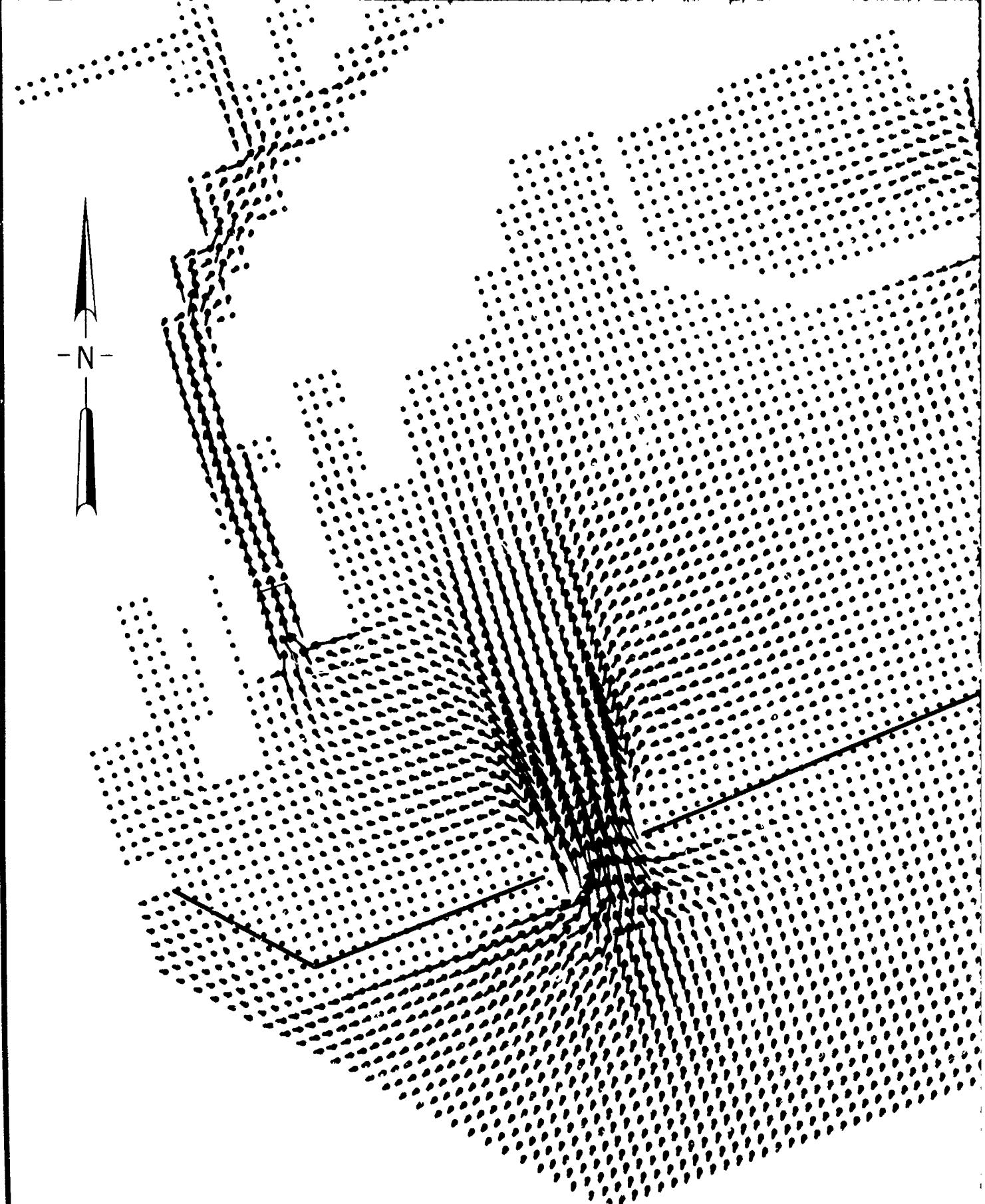


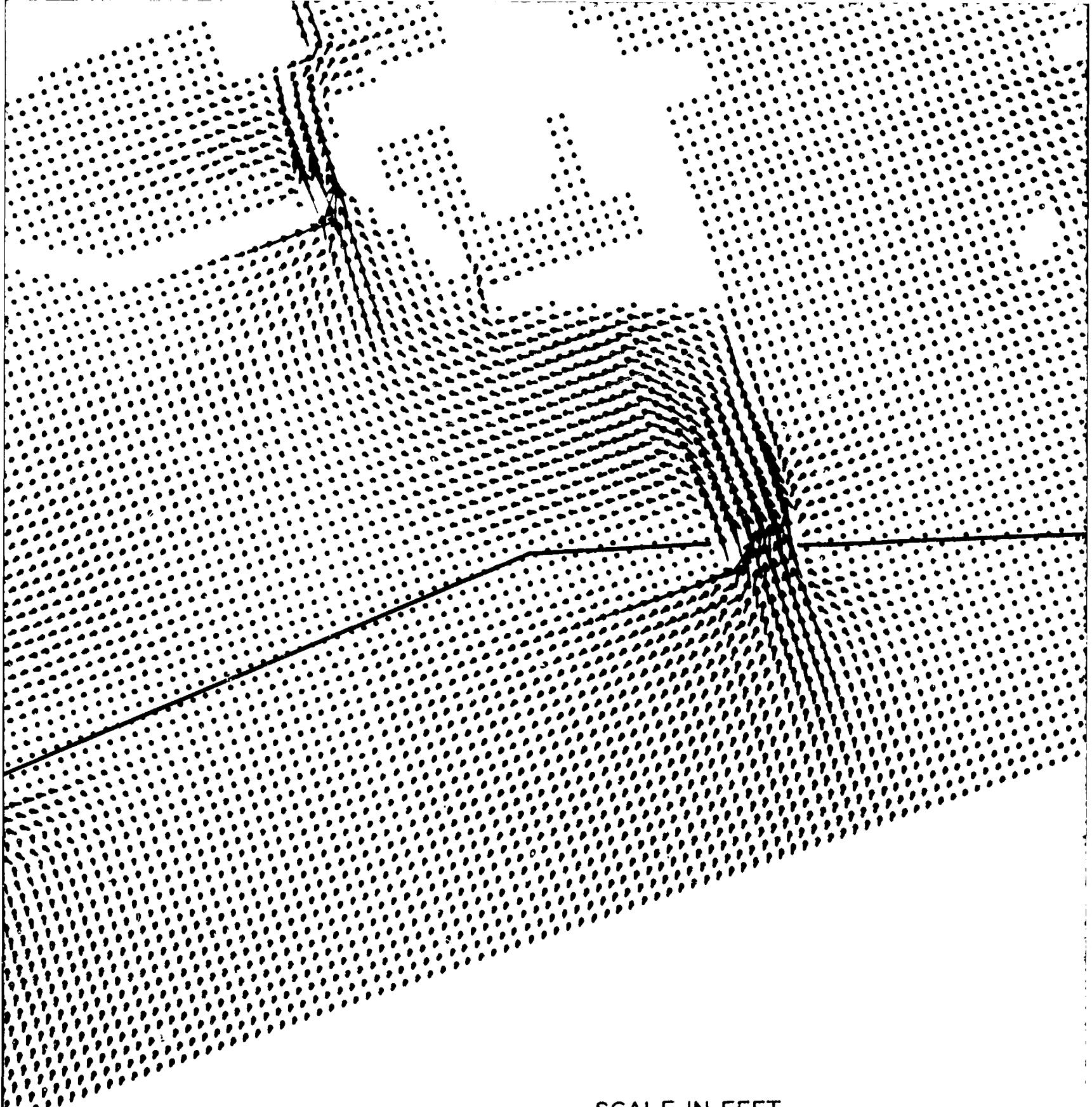
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VELOCITY SCALE

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PROTOTYPE, FPS





SCALE IN FEET

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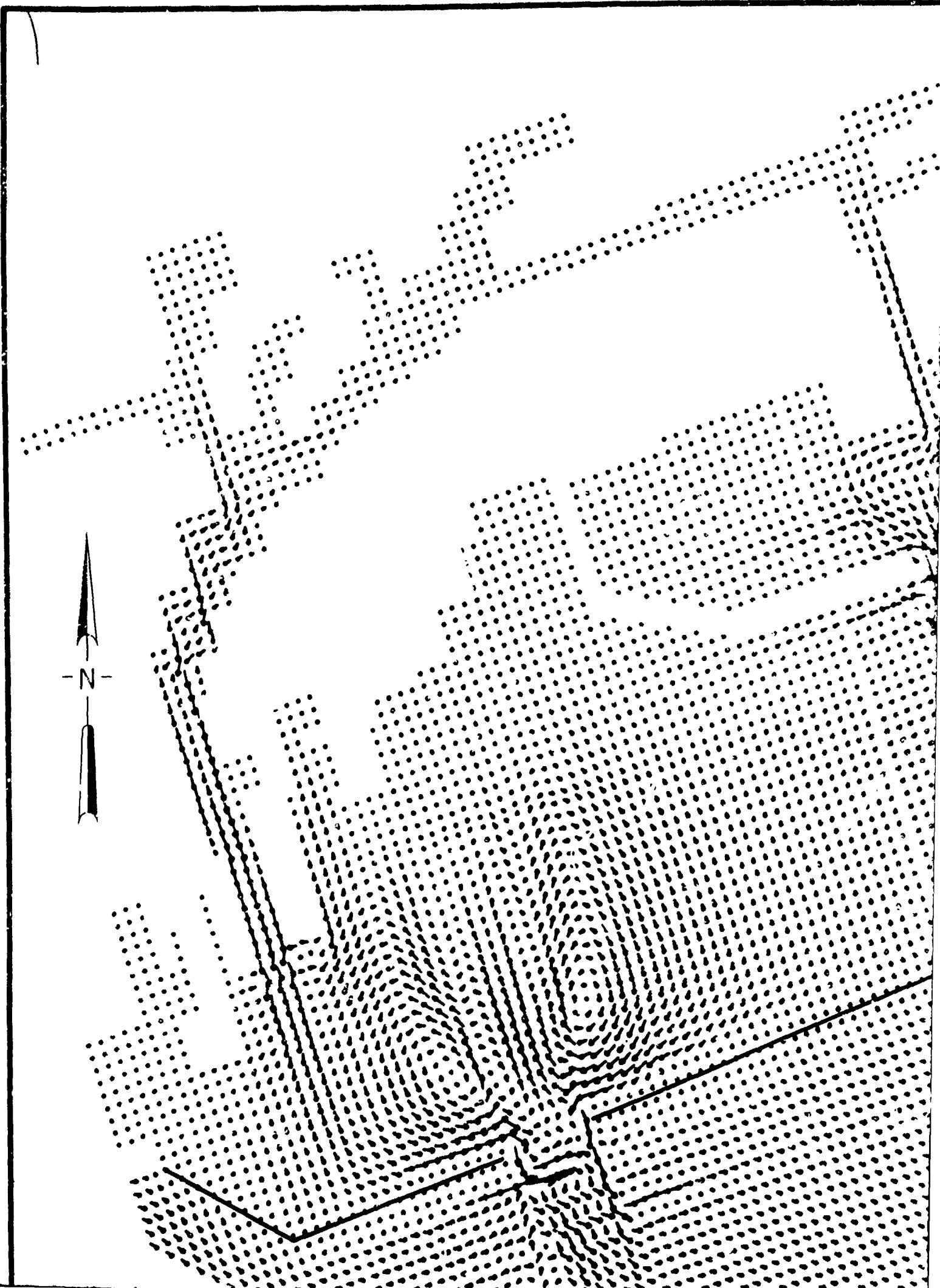
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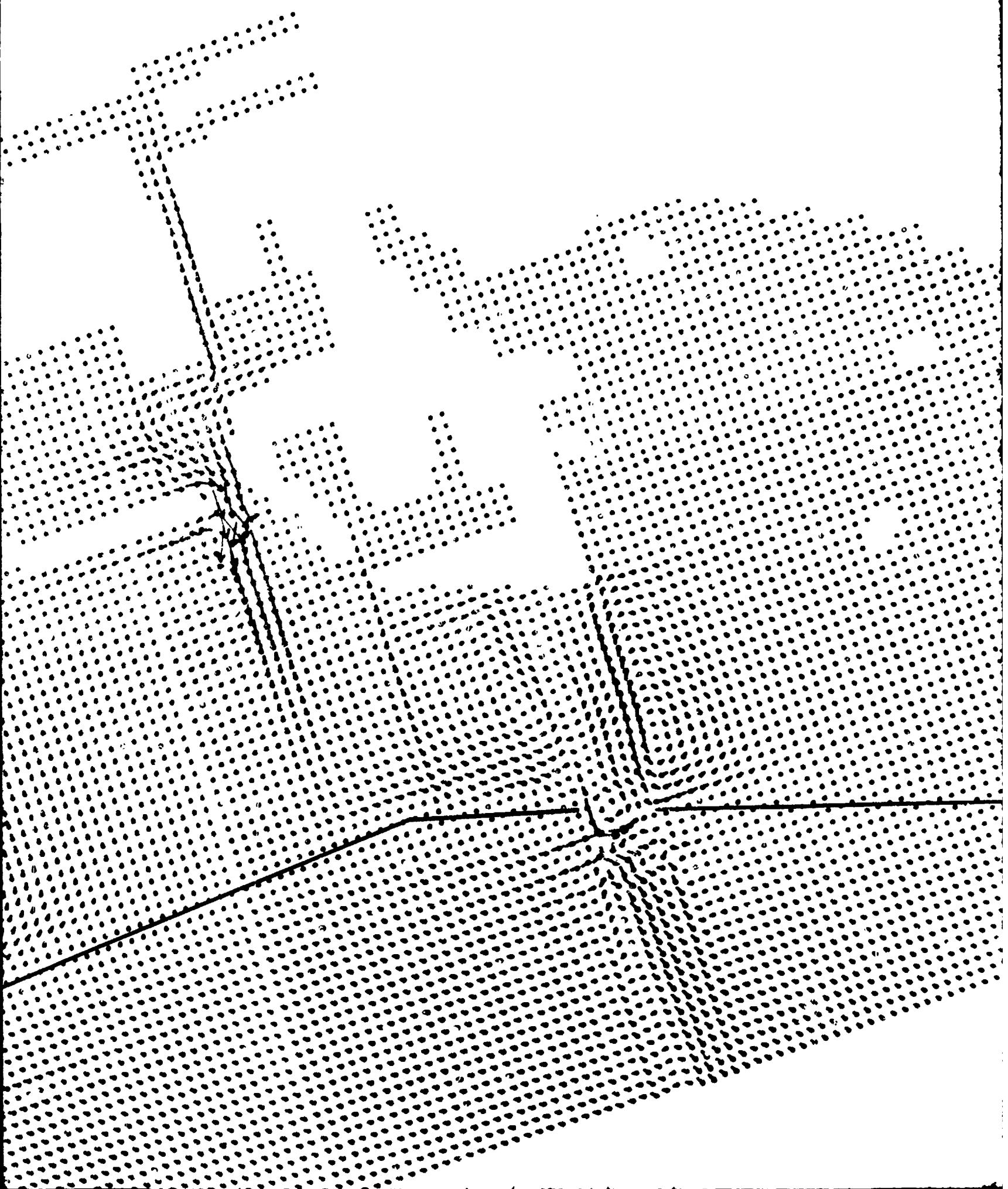
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LONG BEACH - LOS ANGELES HARBORS

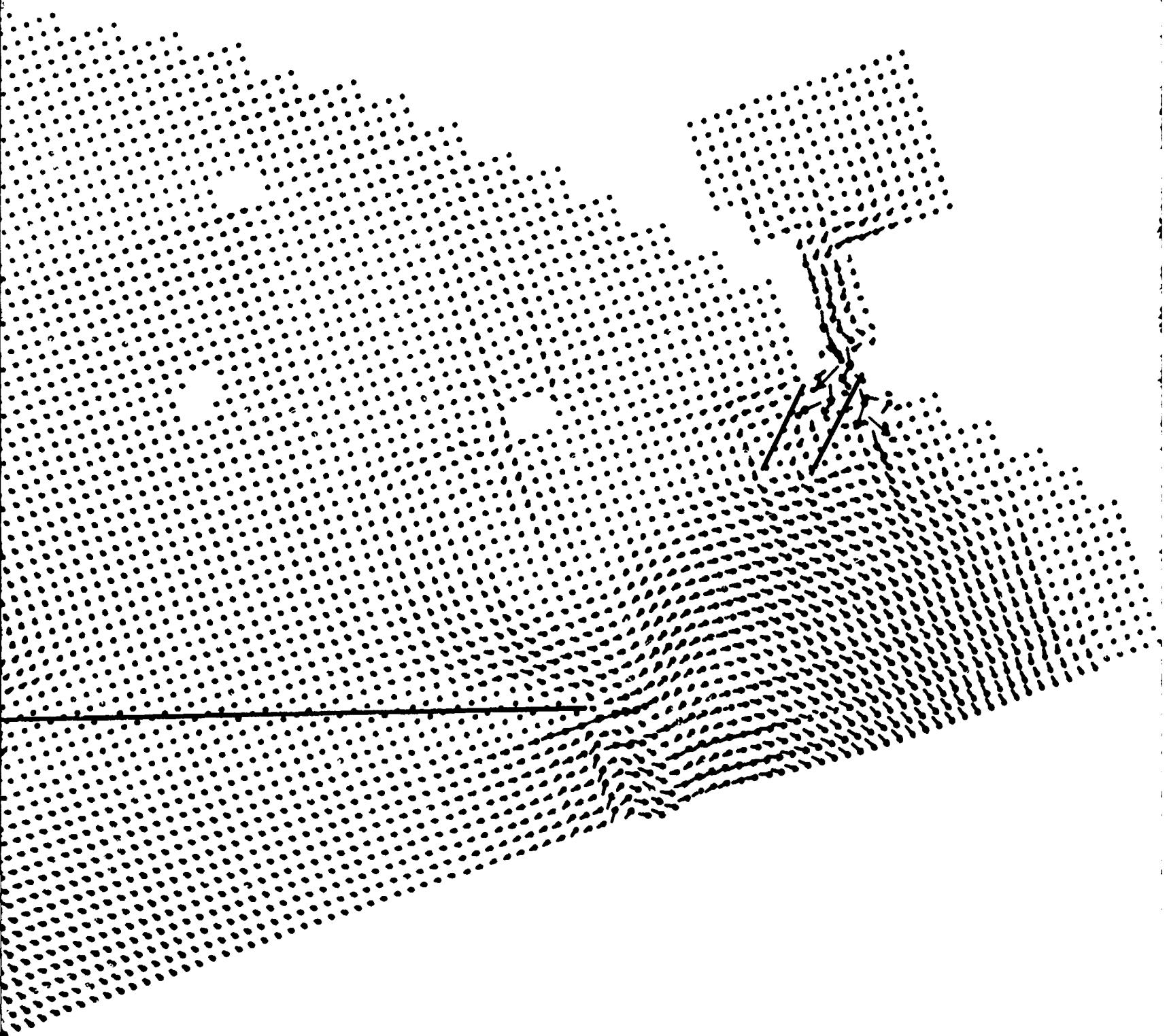
SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 19



2



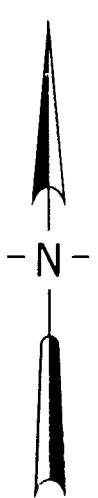
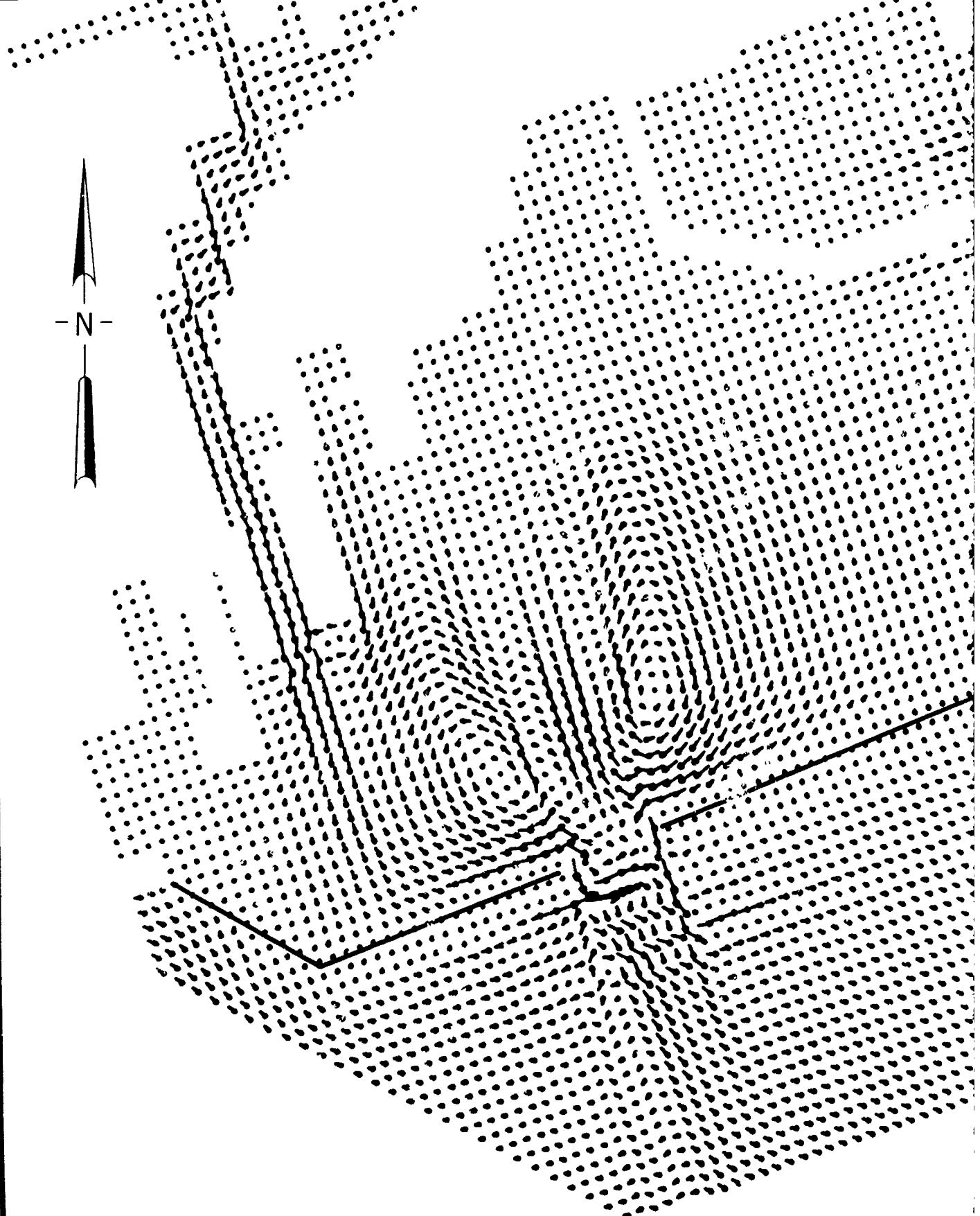


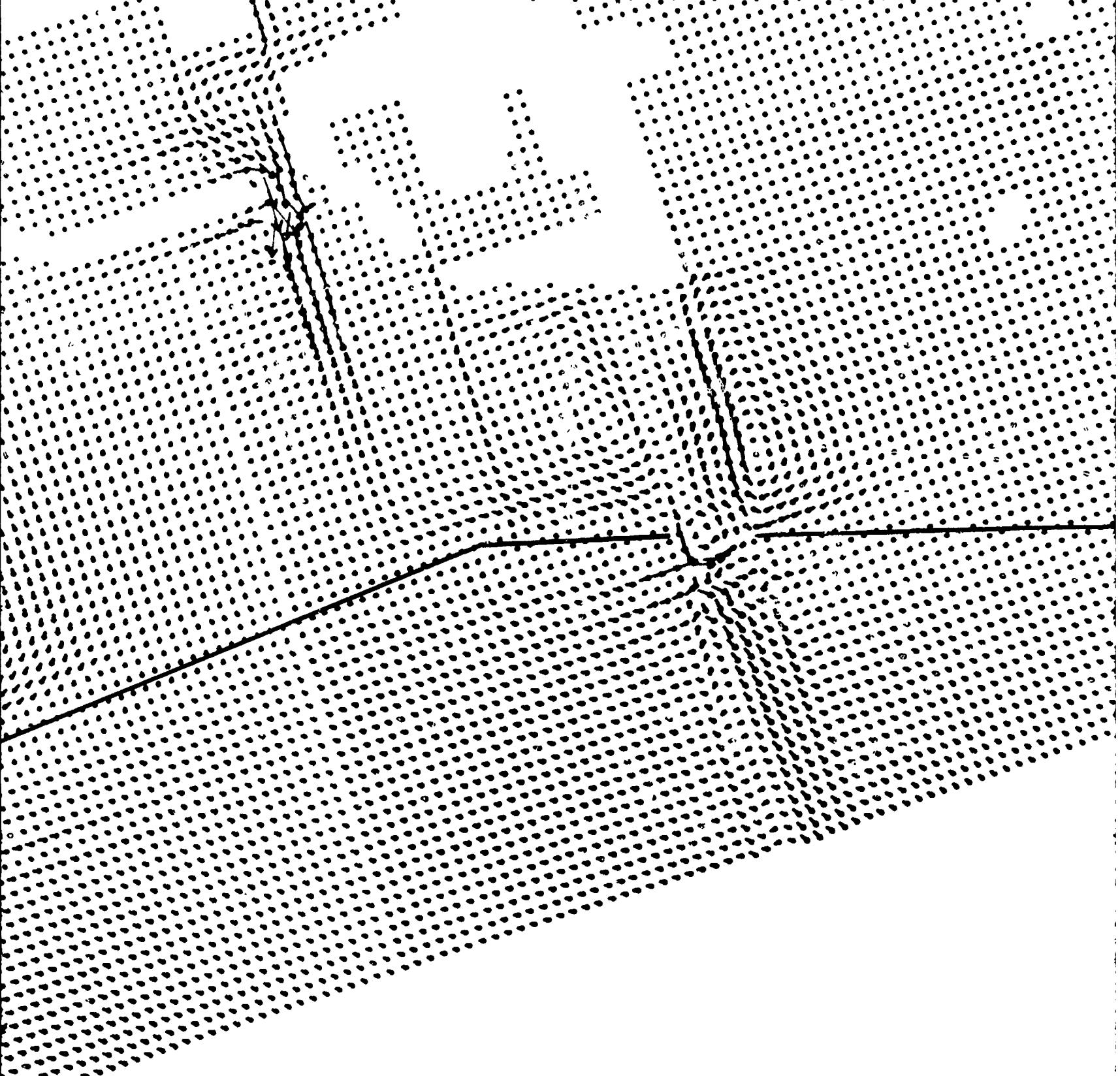
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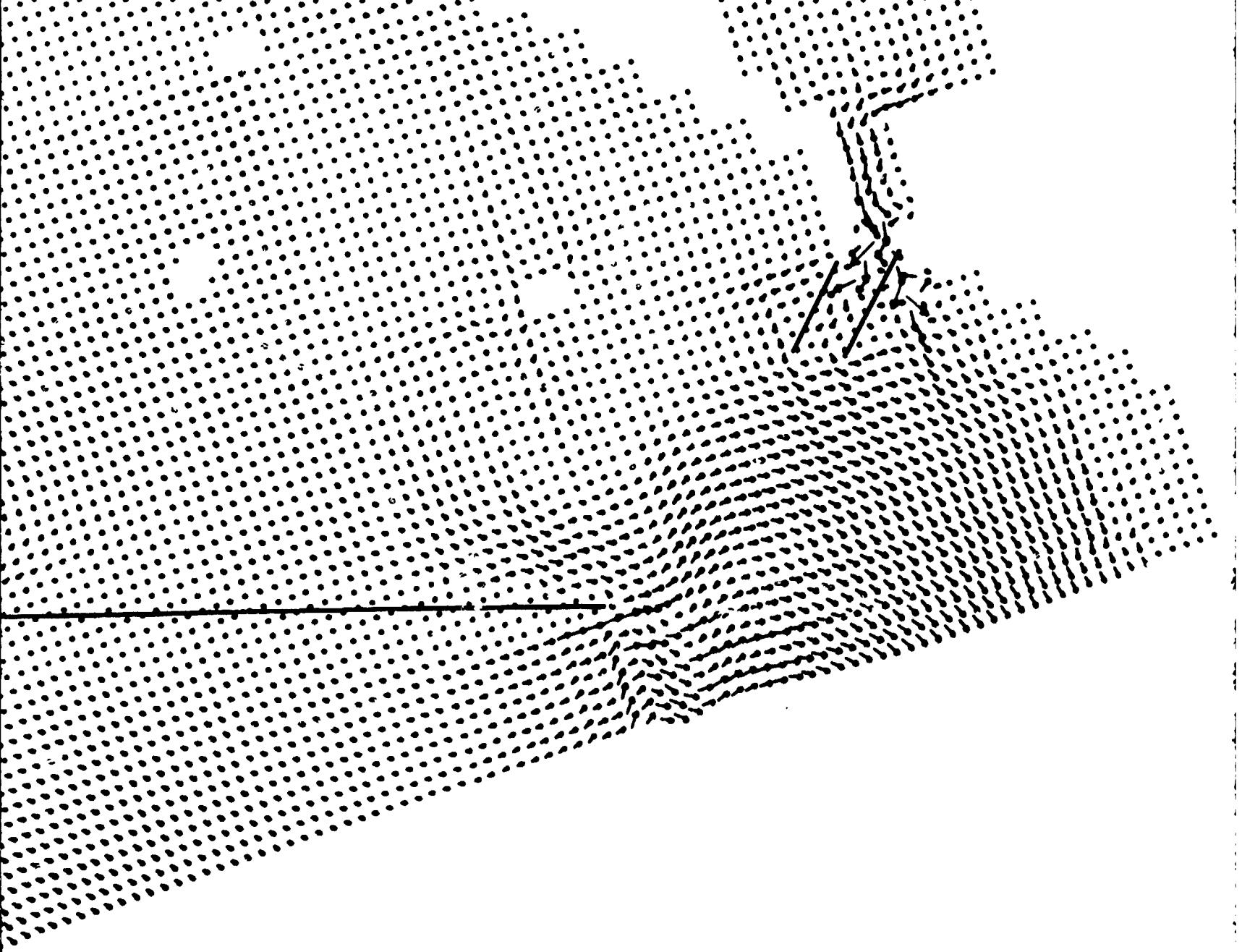
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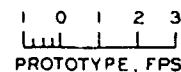


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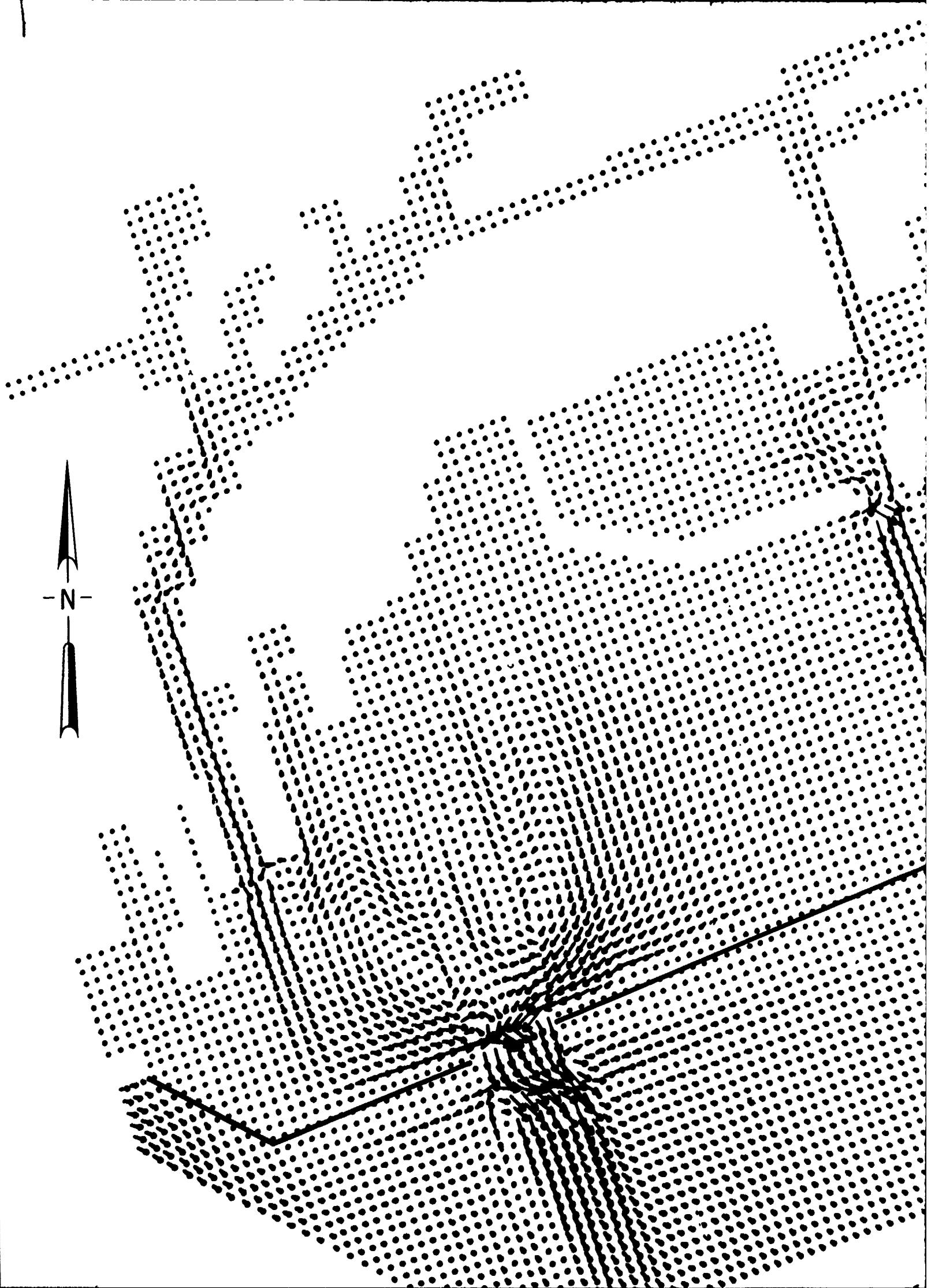
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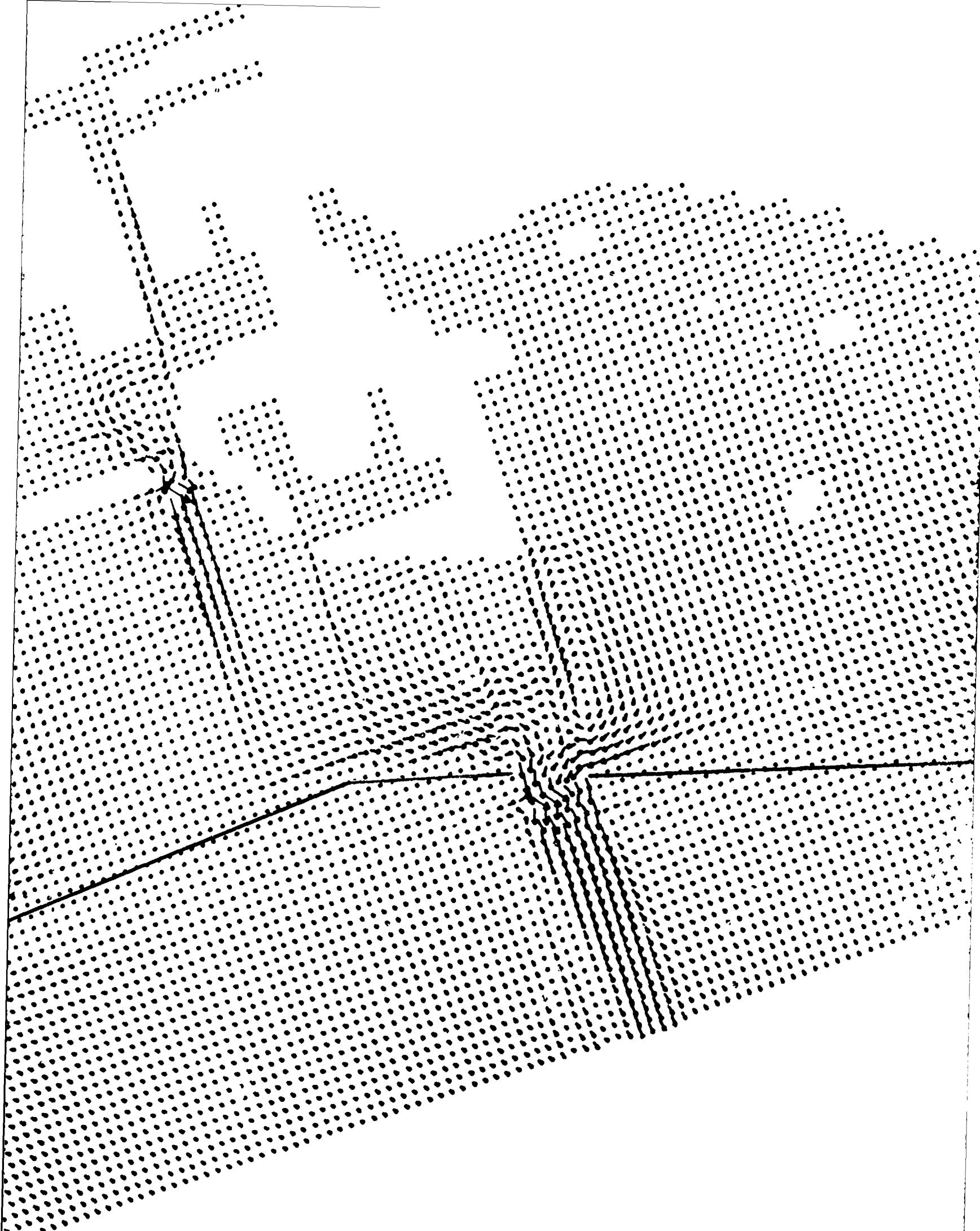


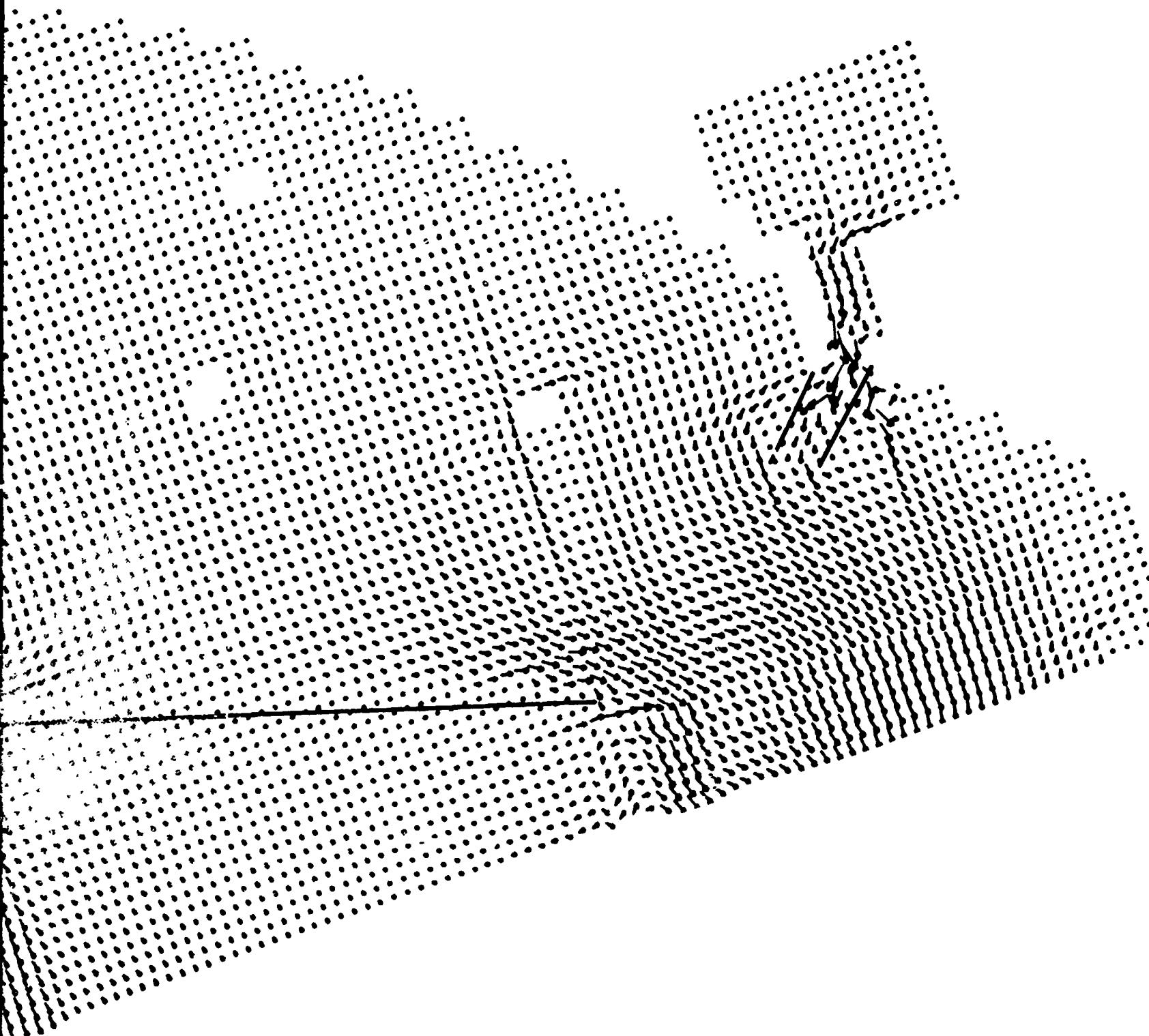
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LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 22





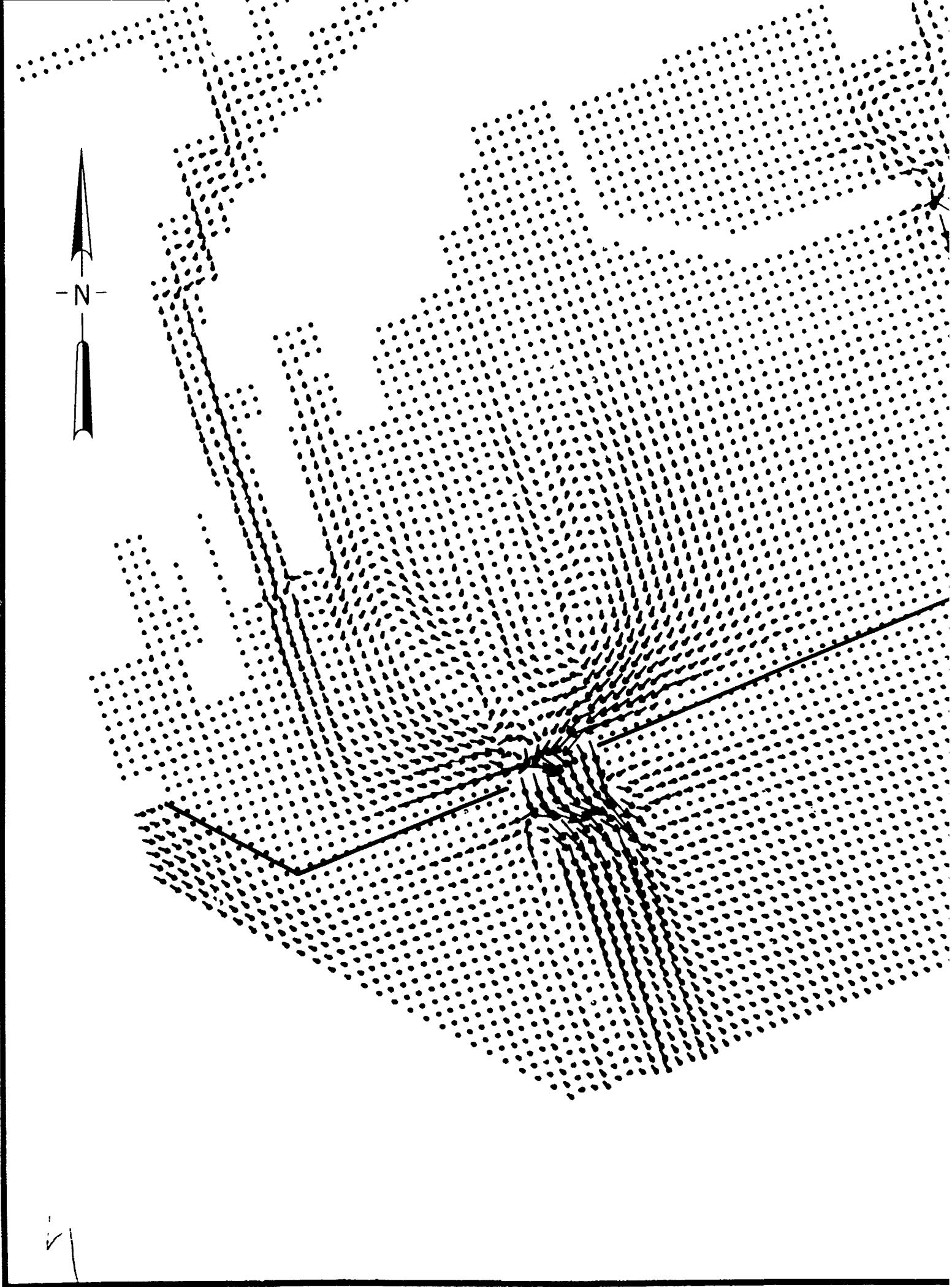


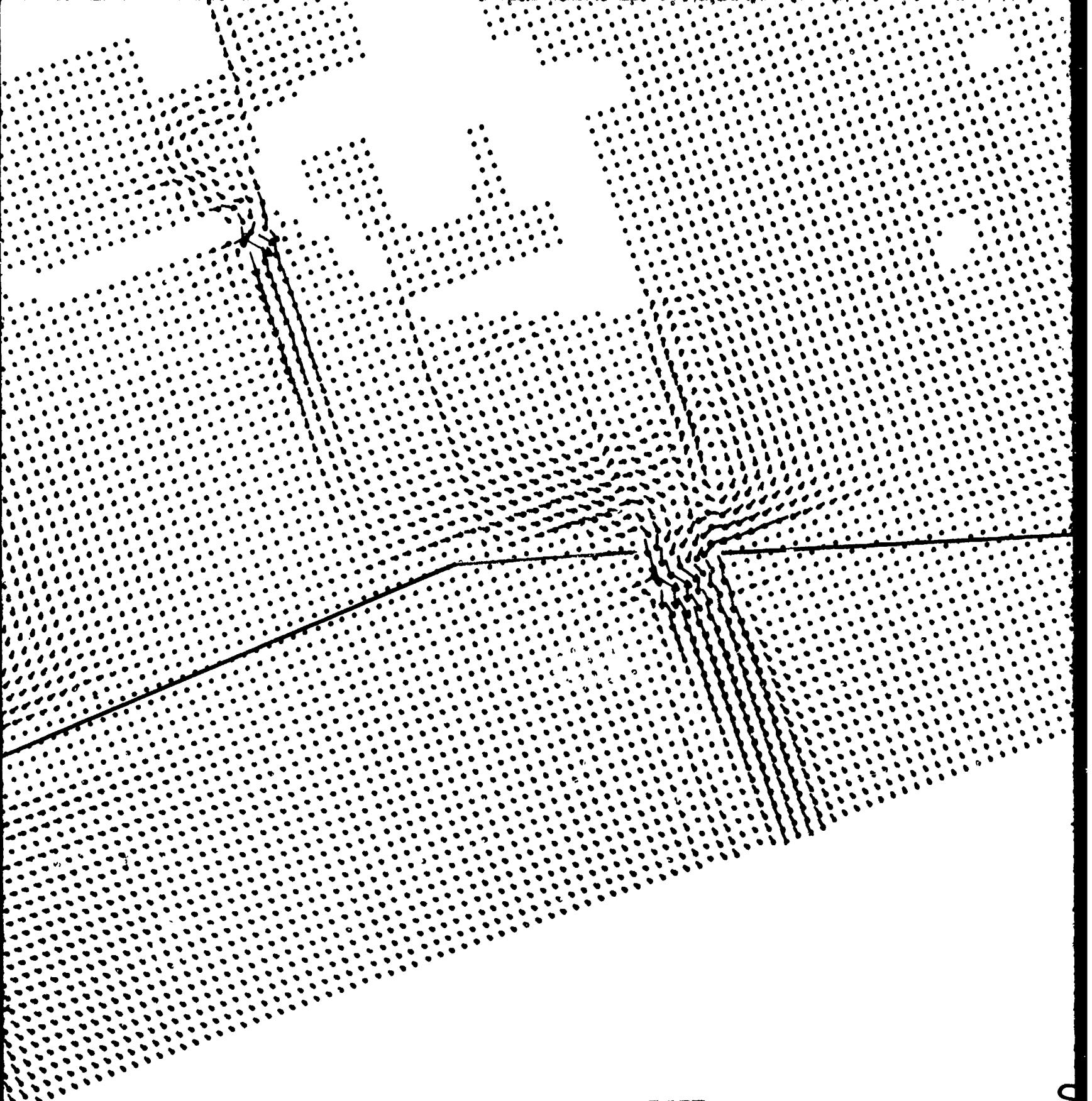
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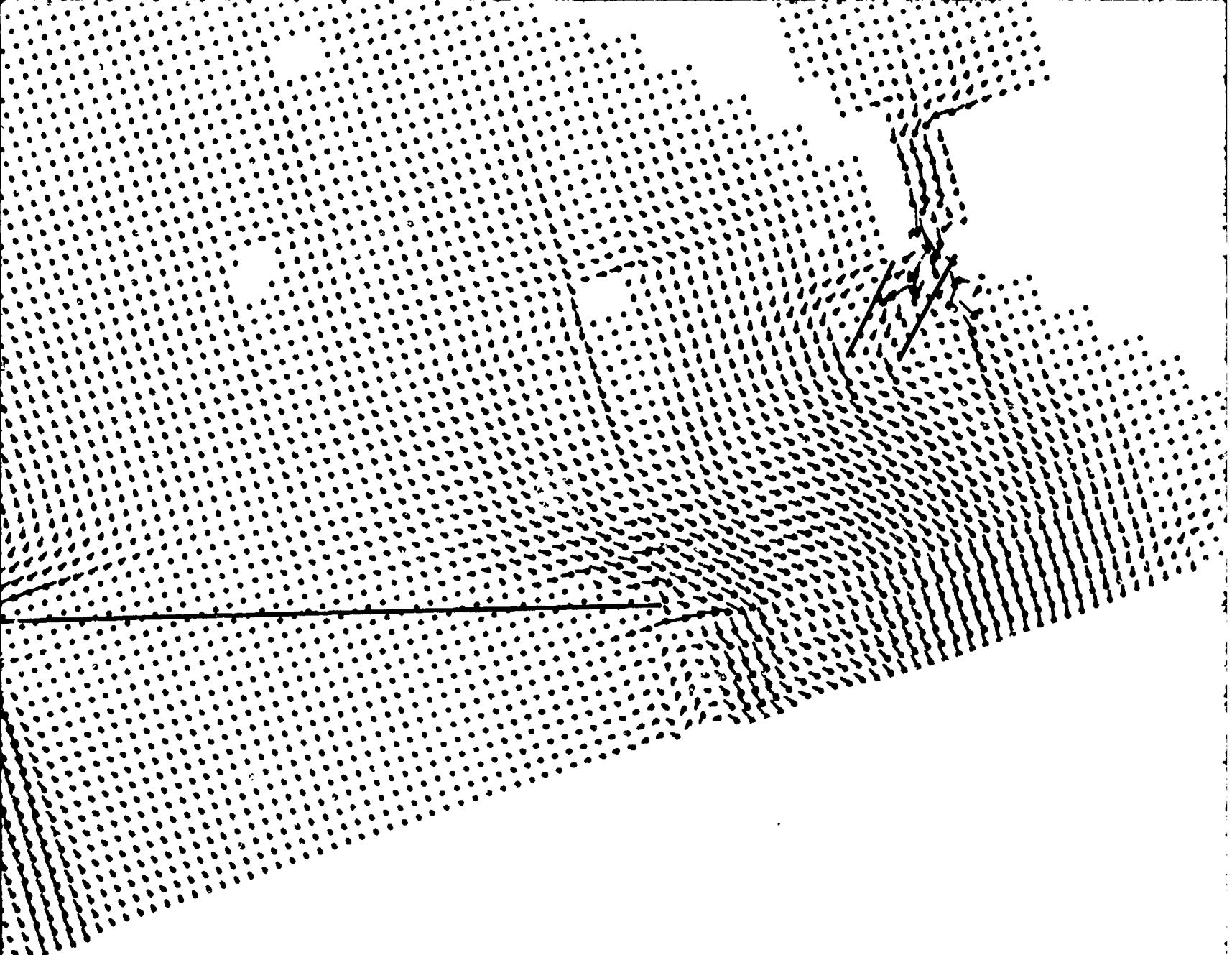
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LONG BEACH-LOS ANGELES HARBORS





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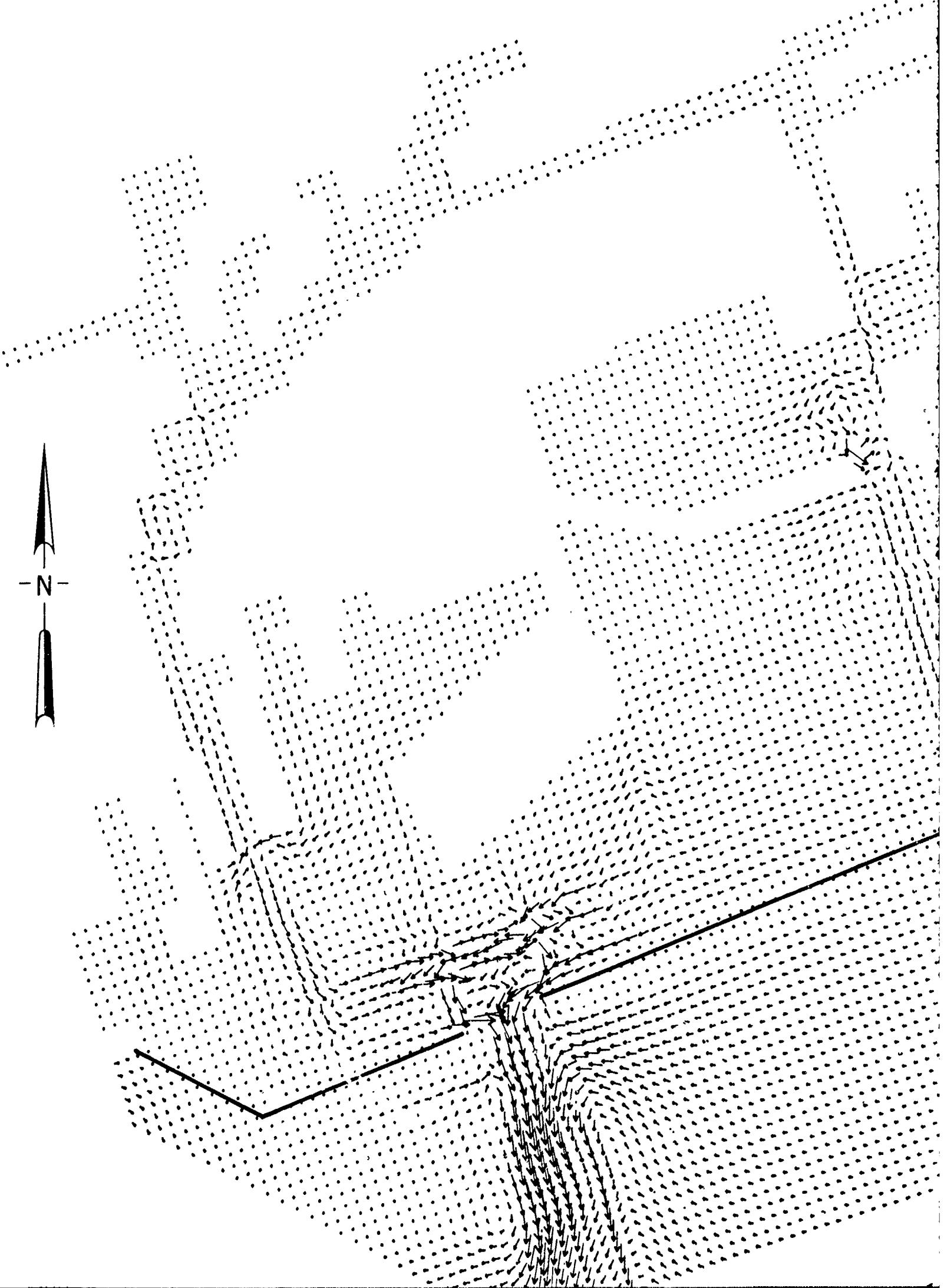
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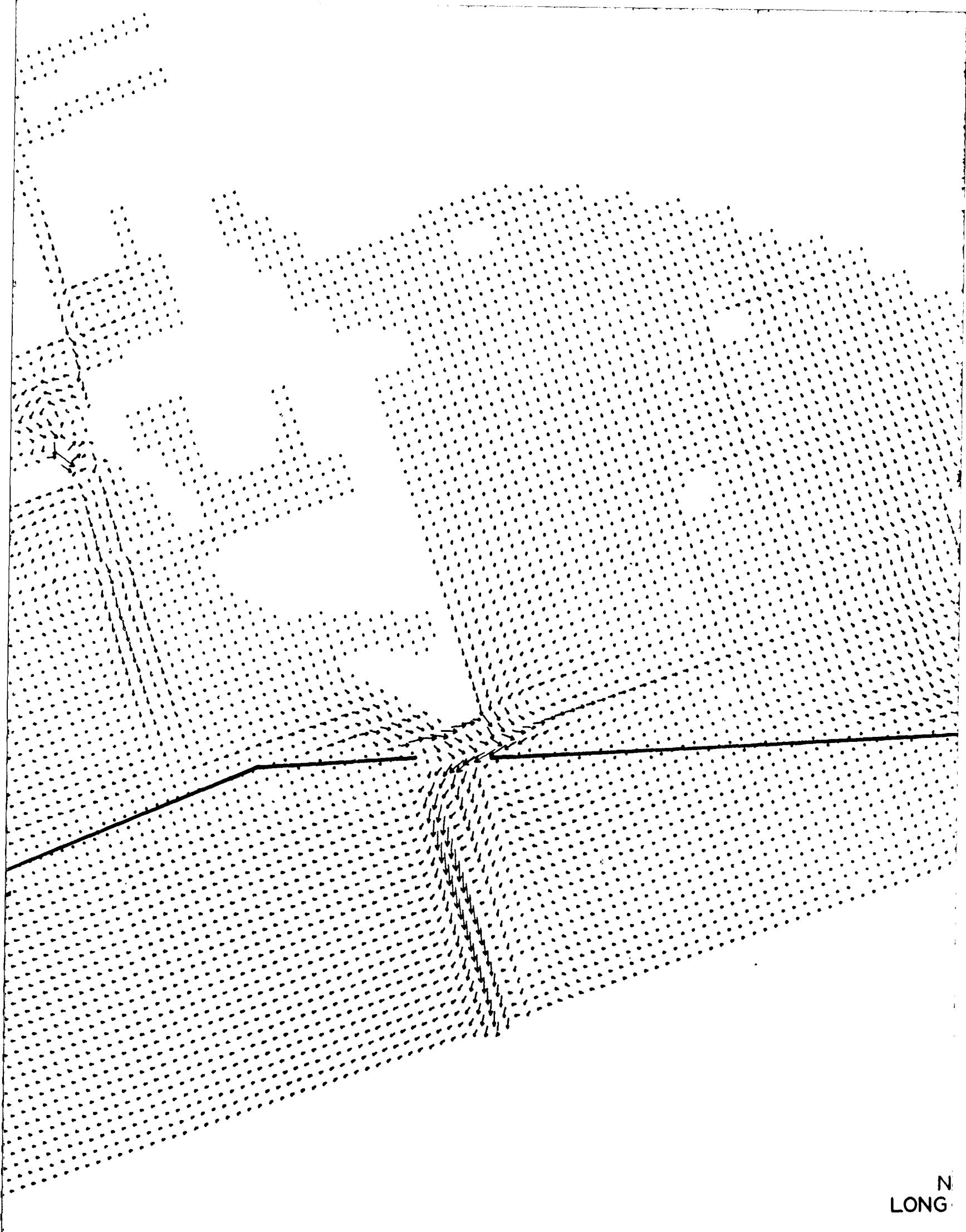
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LONG BEACH - LOS ANGELES HARBORS

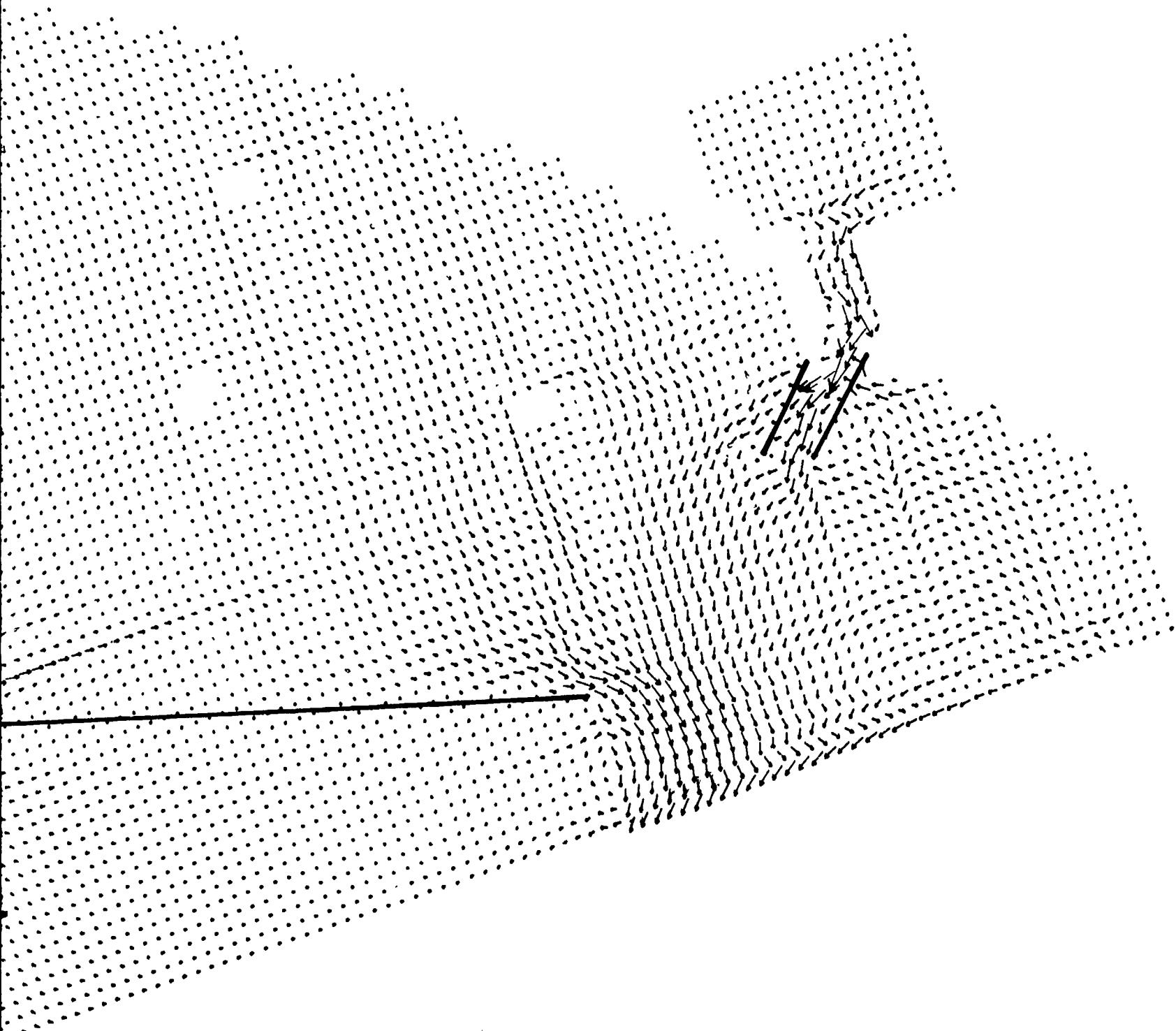
SURFACE CURRENT PATTERNS

EXISTING CONDITIONS
SPRING TIDE
HOUR 24





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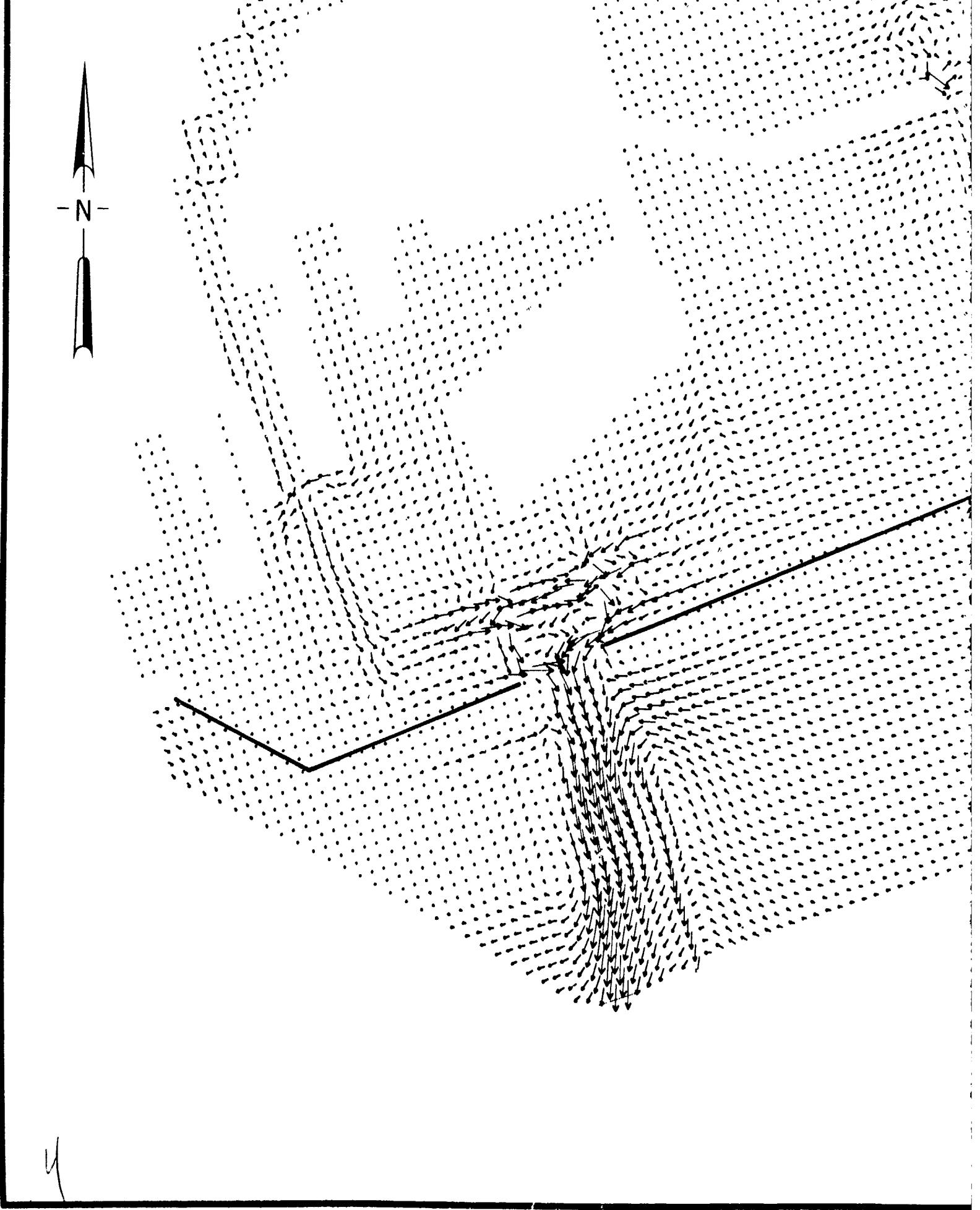


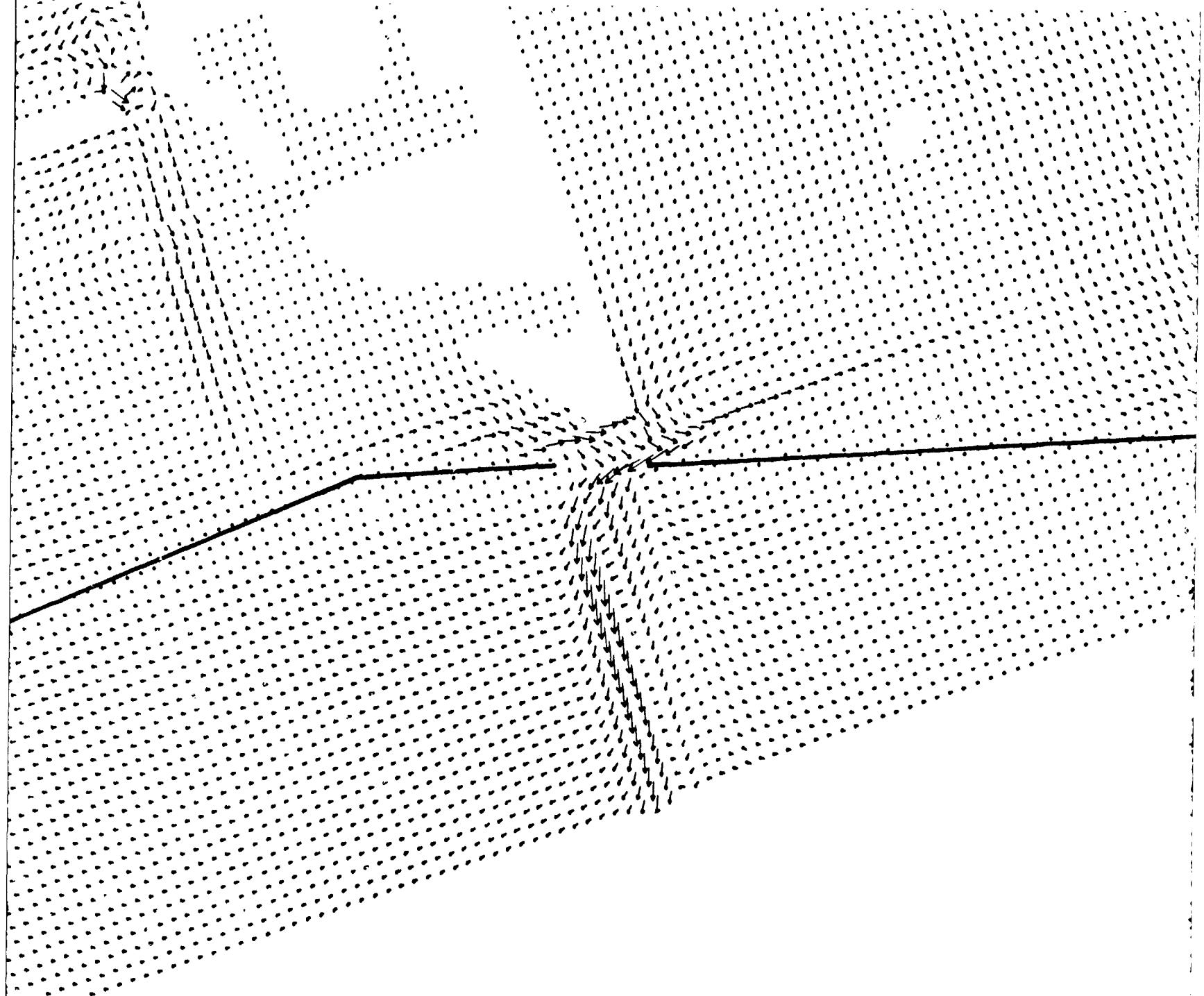
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LONG BEACH - LOS ANGELES HARBORS



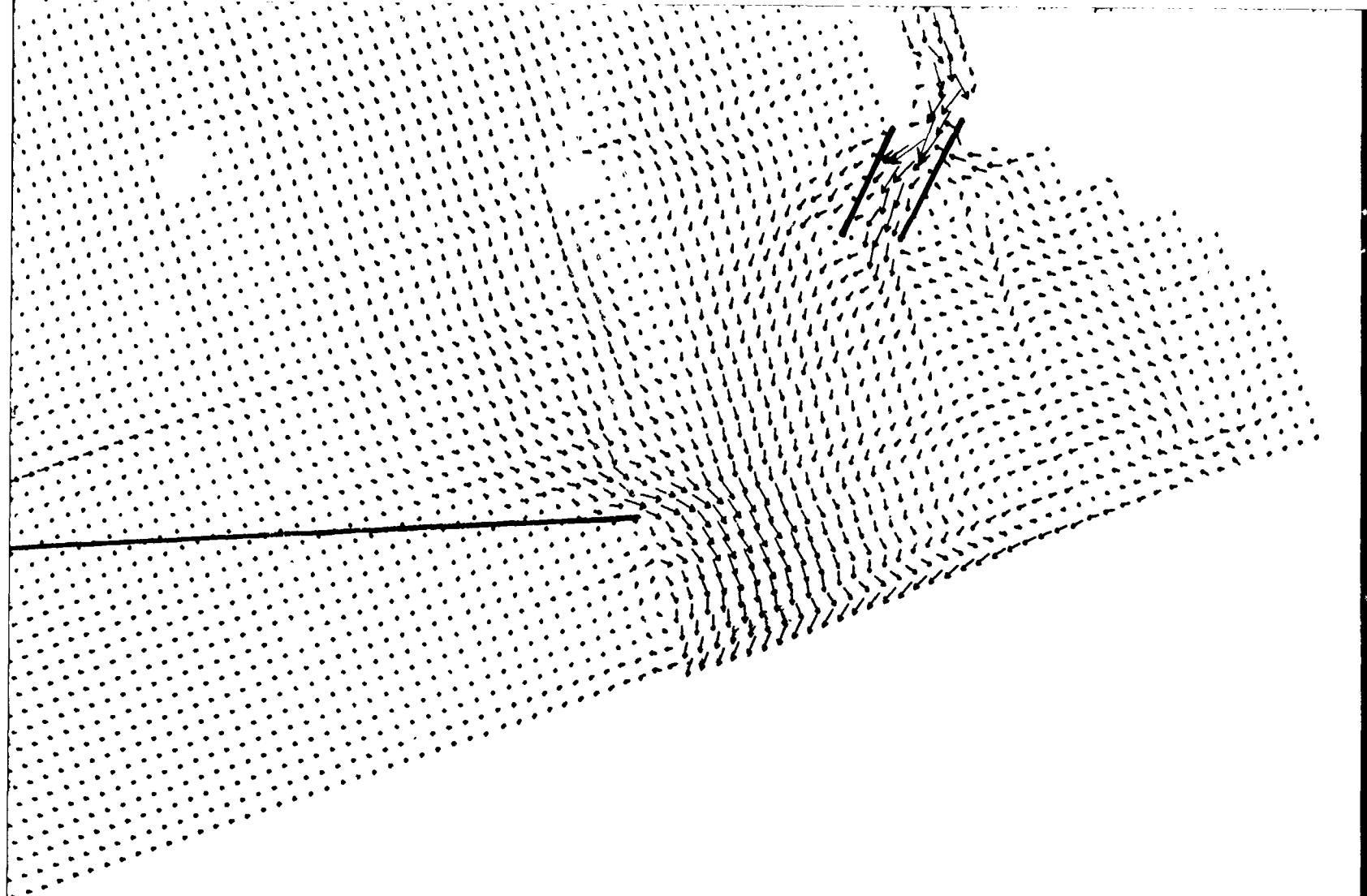


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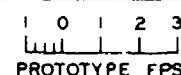
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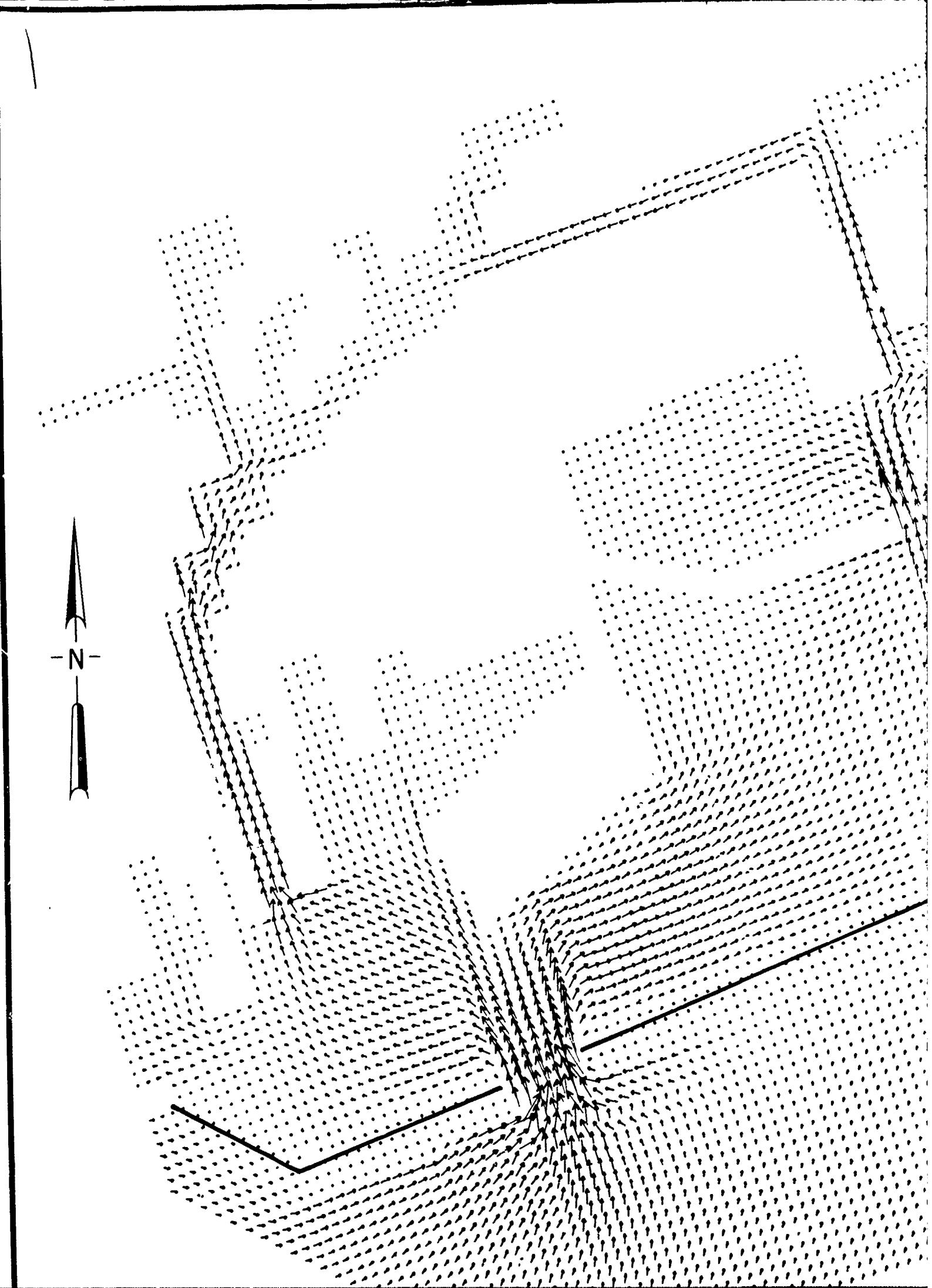
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LONG BEACH - LOS ANGELES HARBORS

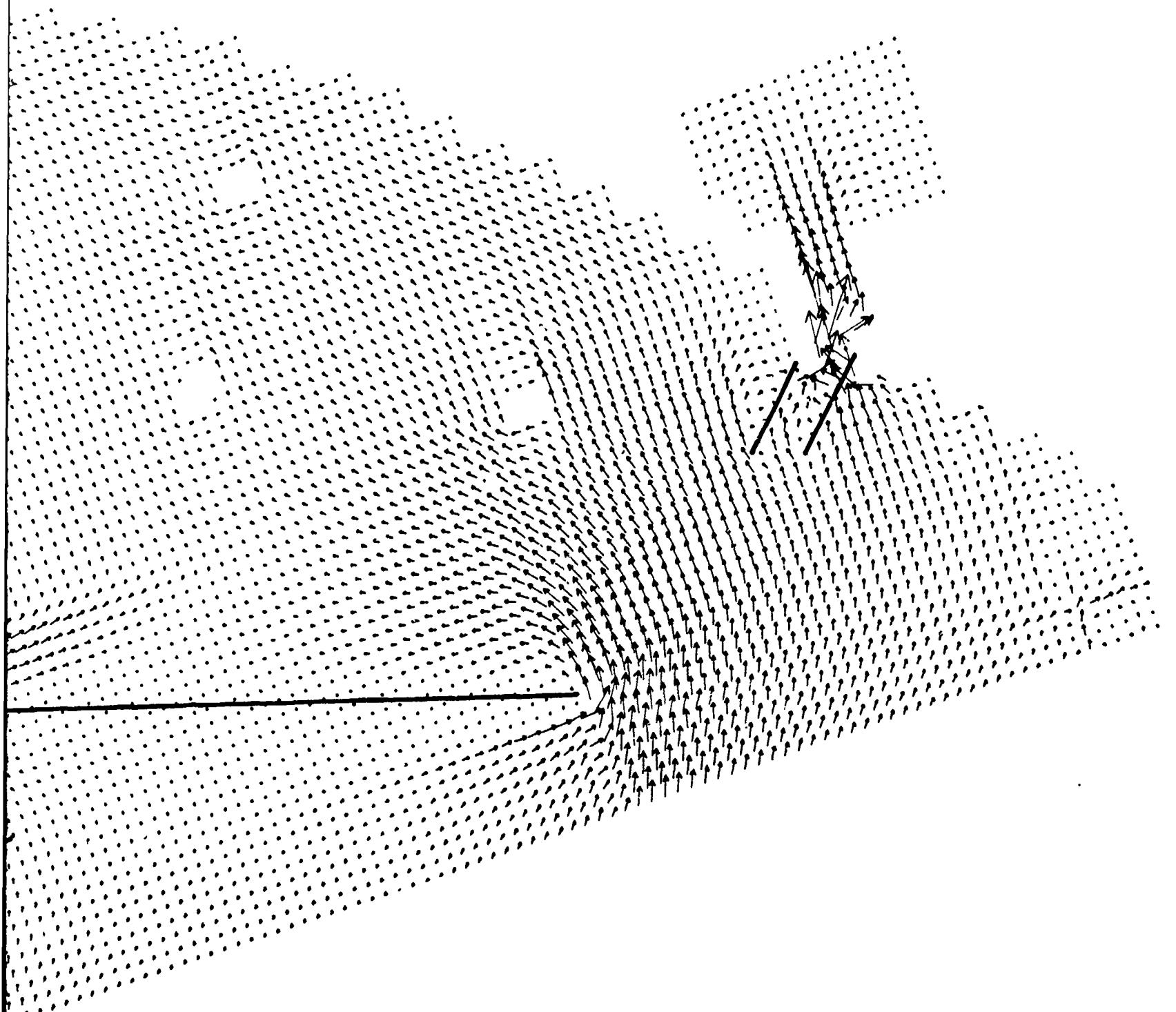
SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 15

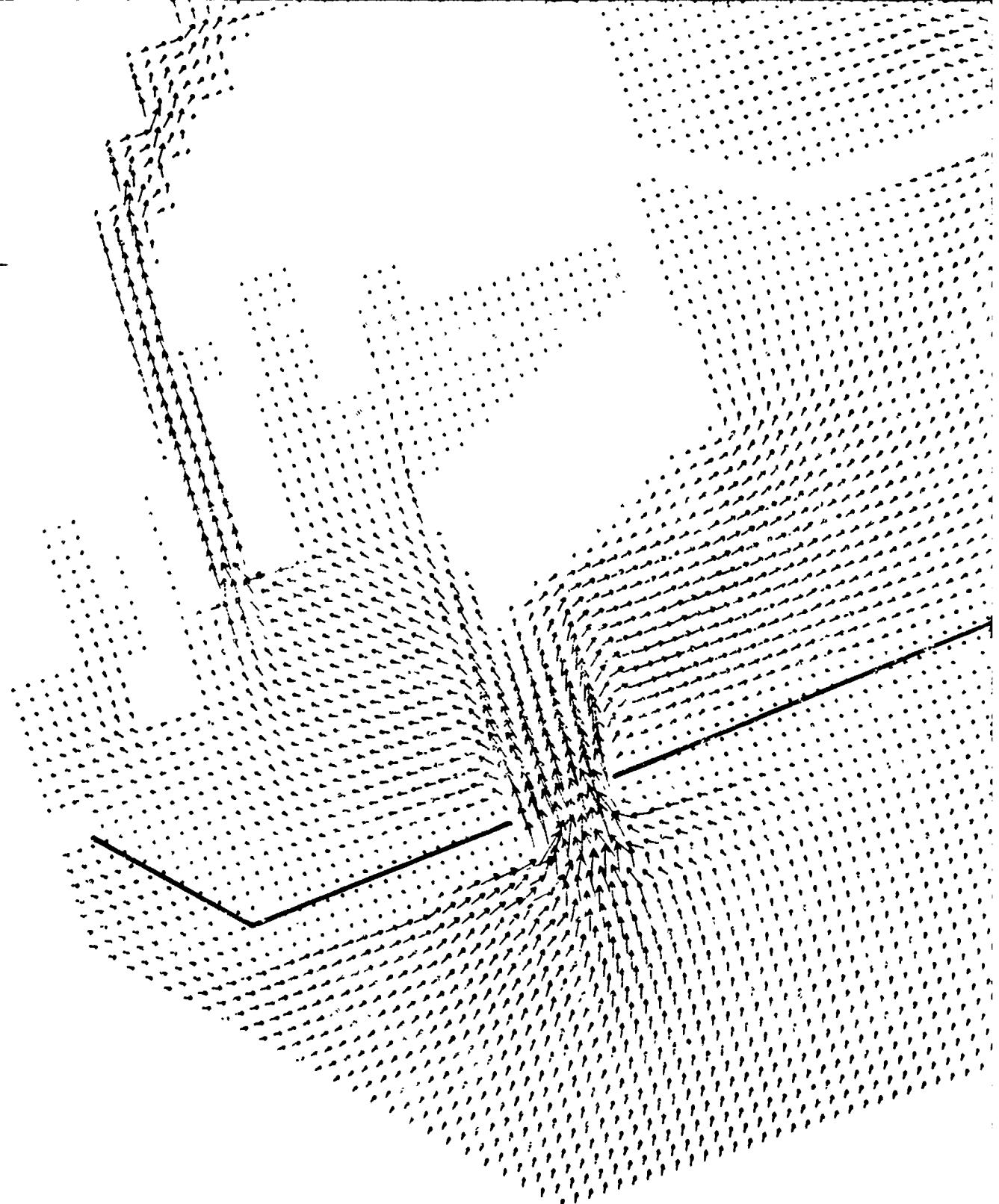
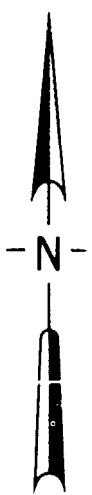


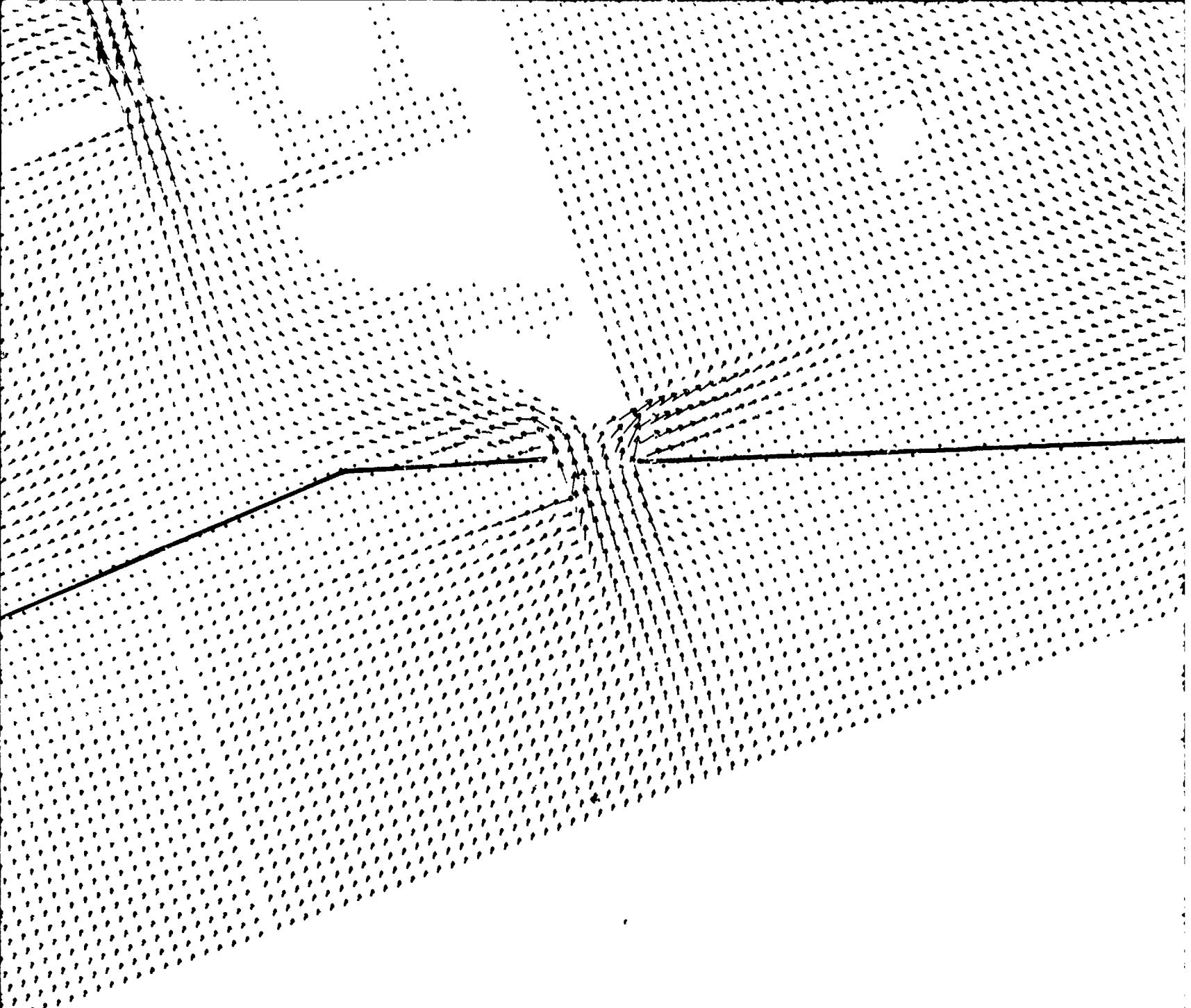
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VELOCITY SCALE
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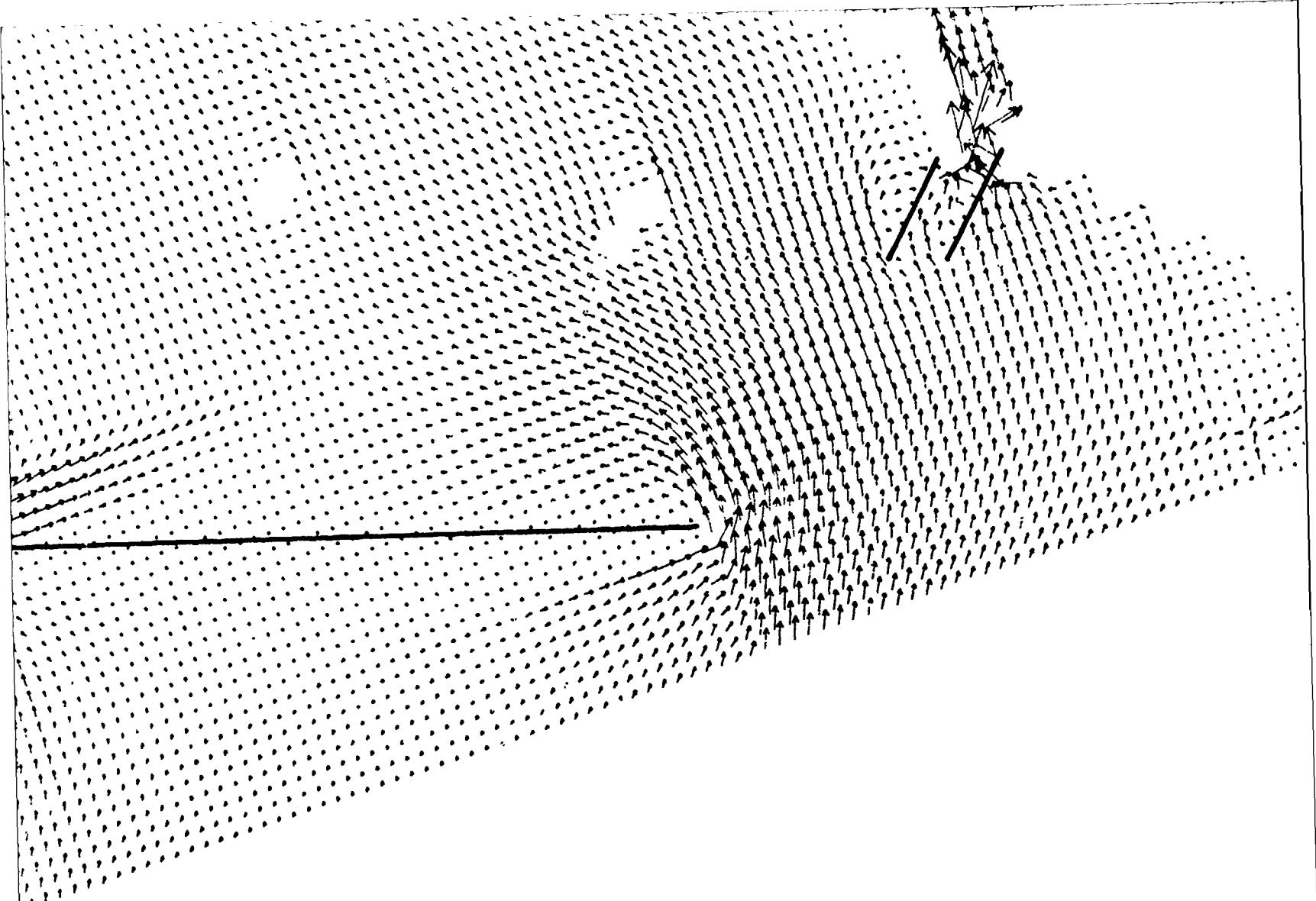
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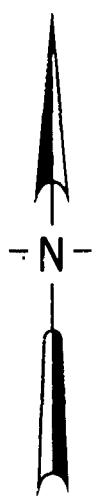
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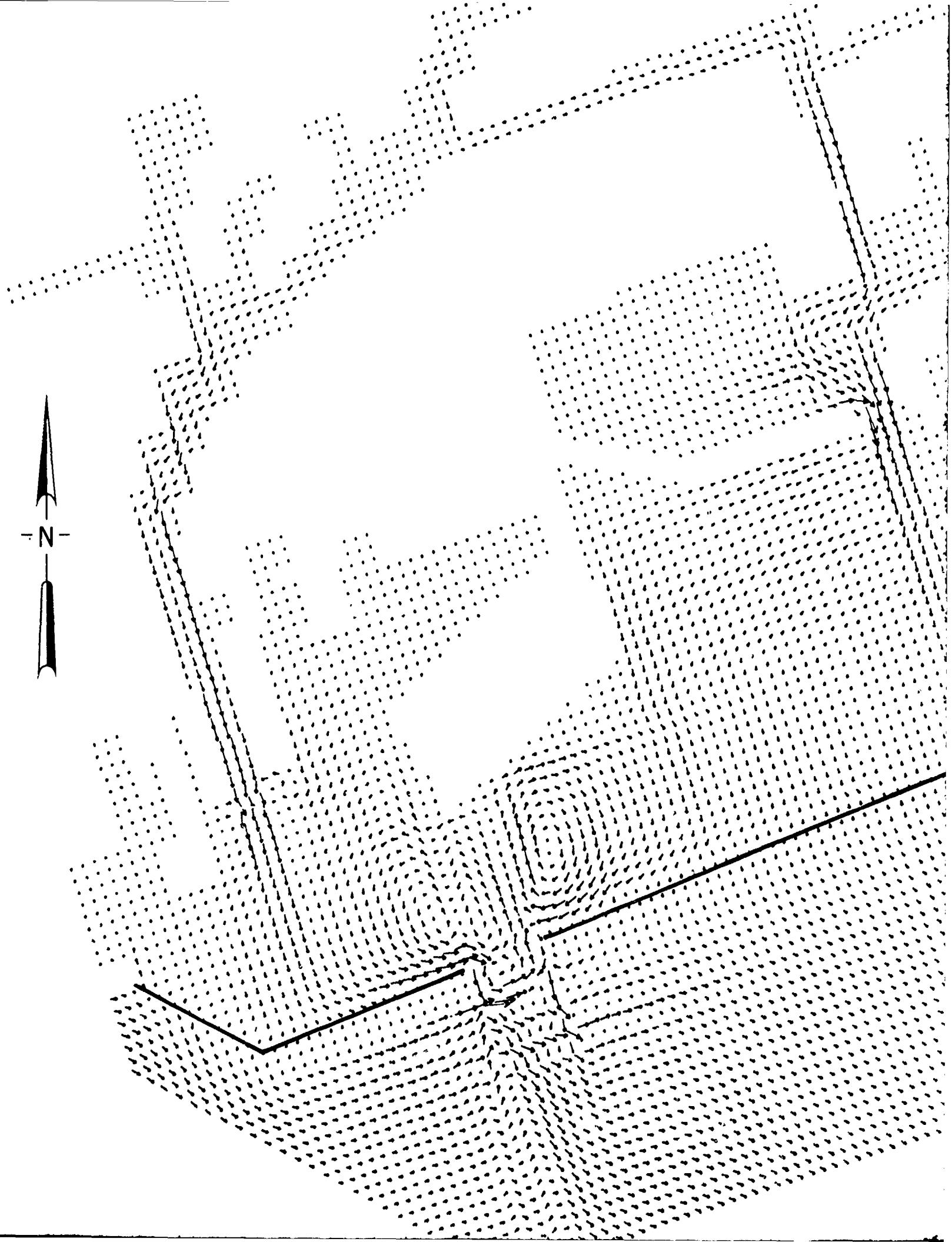
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LONG BEACH - LOS ANGELES HARBORS

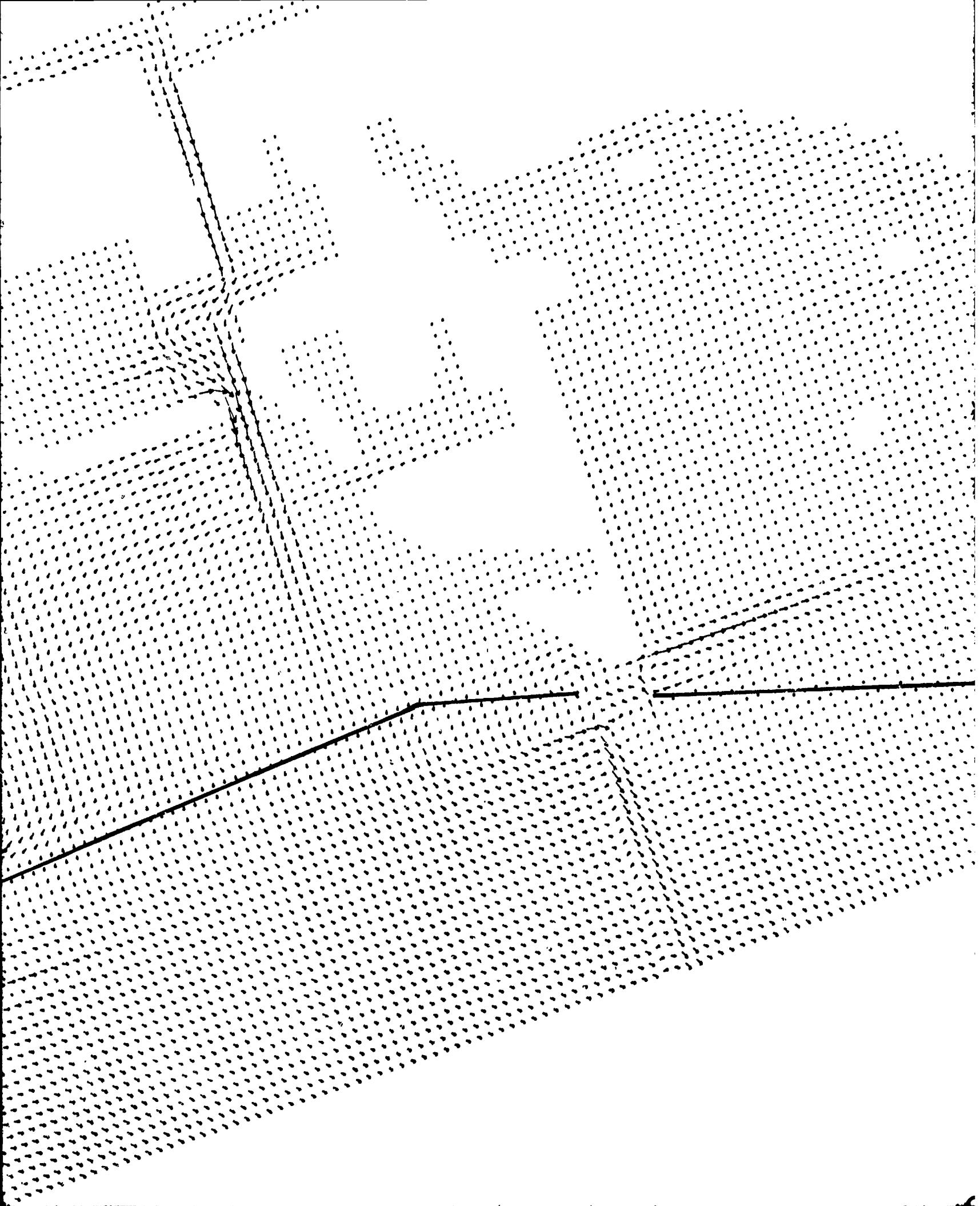
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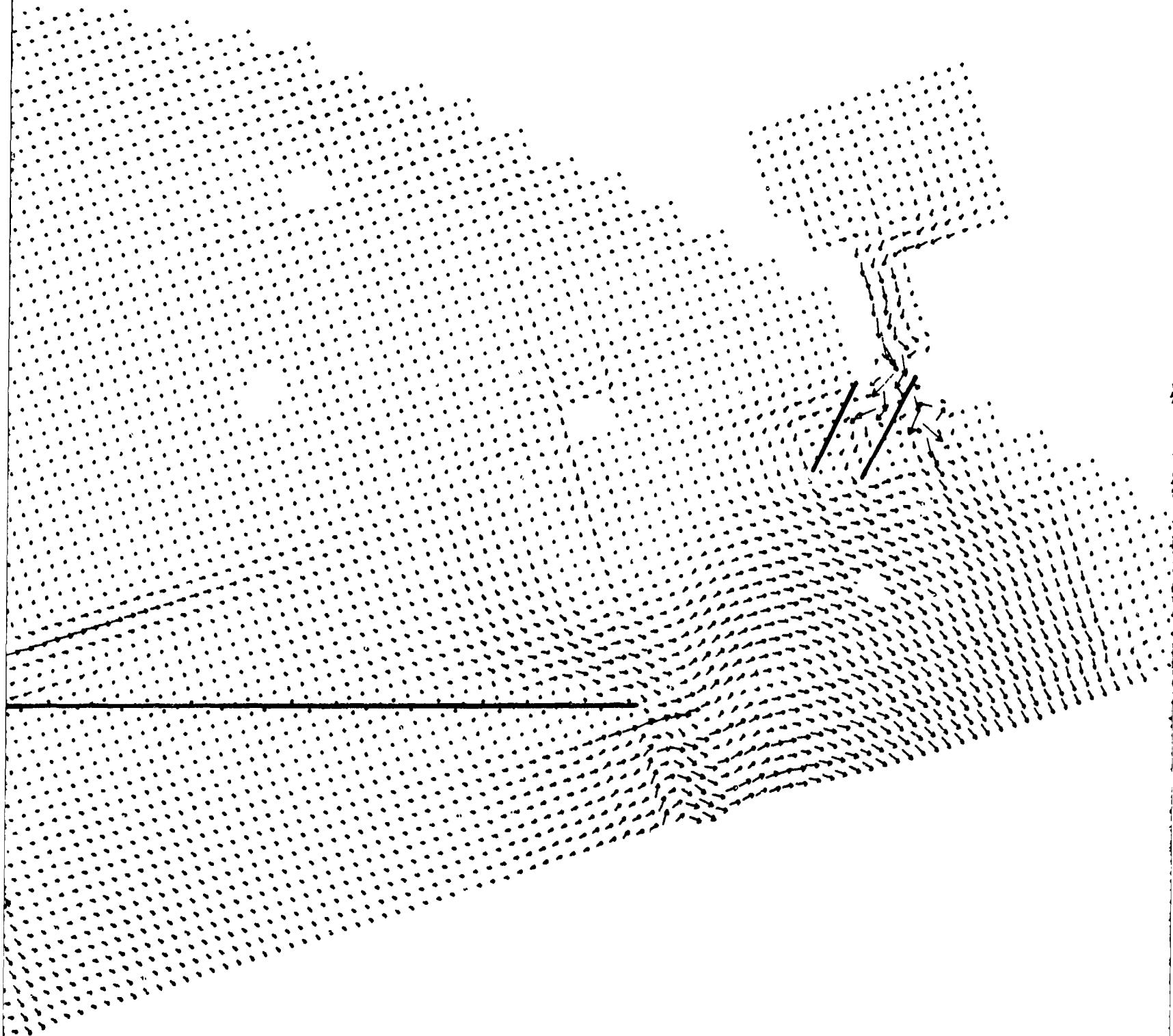
PLAN 1A-2
SPRING TIDE
HOUR 19



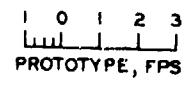
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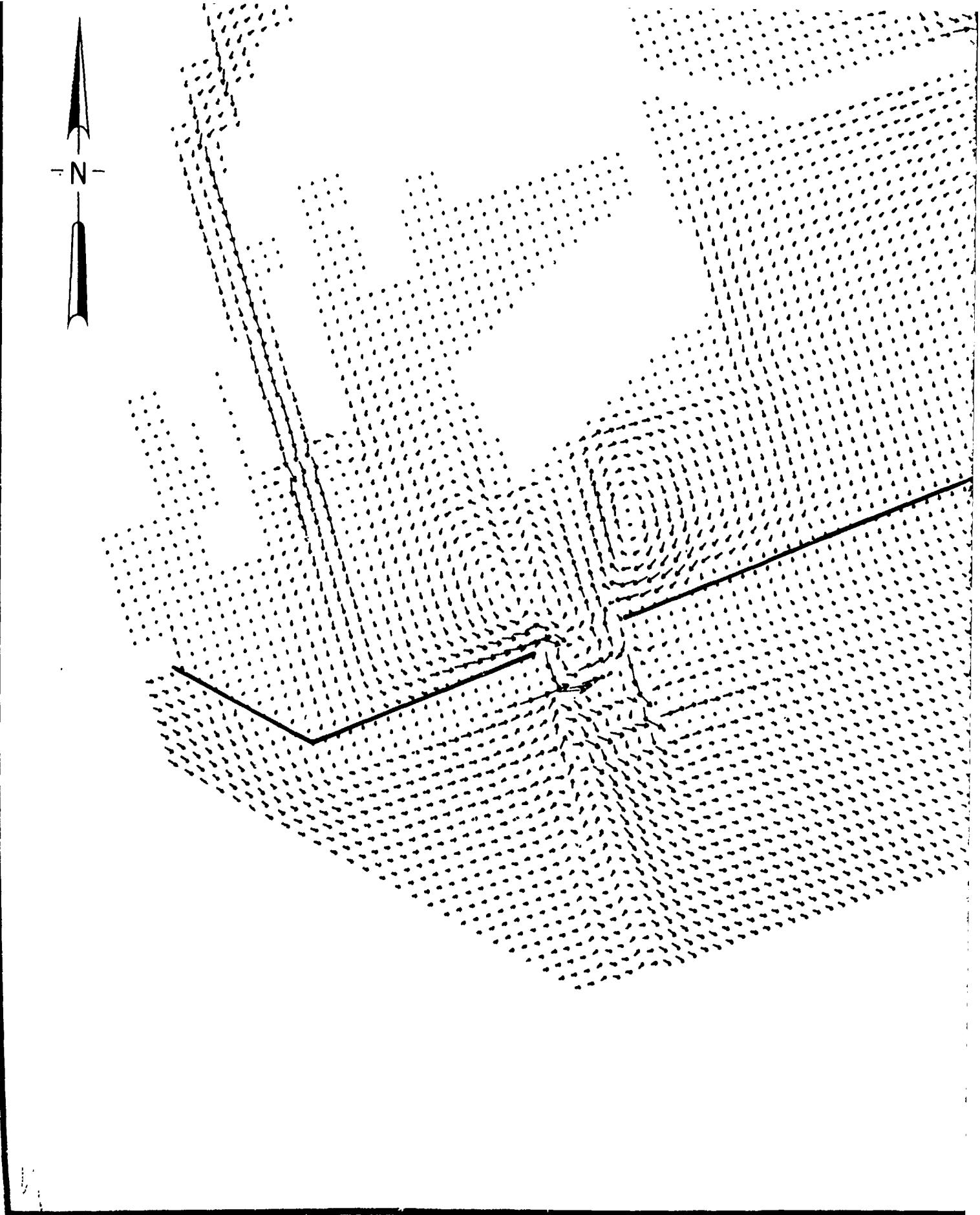


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

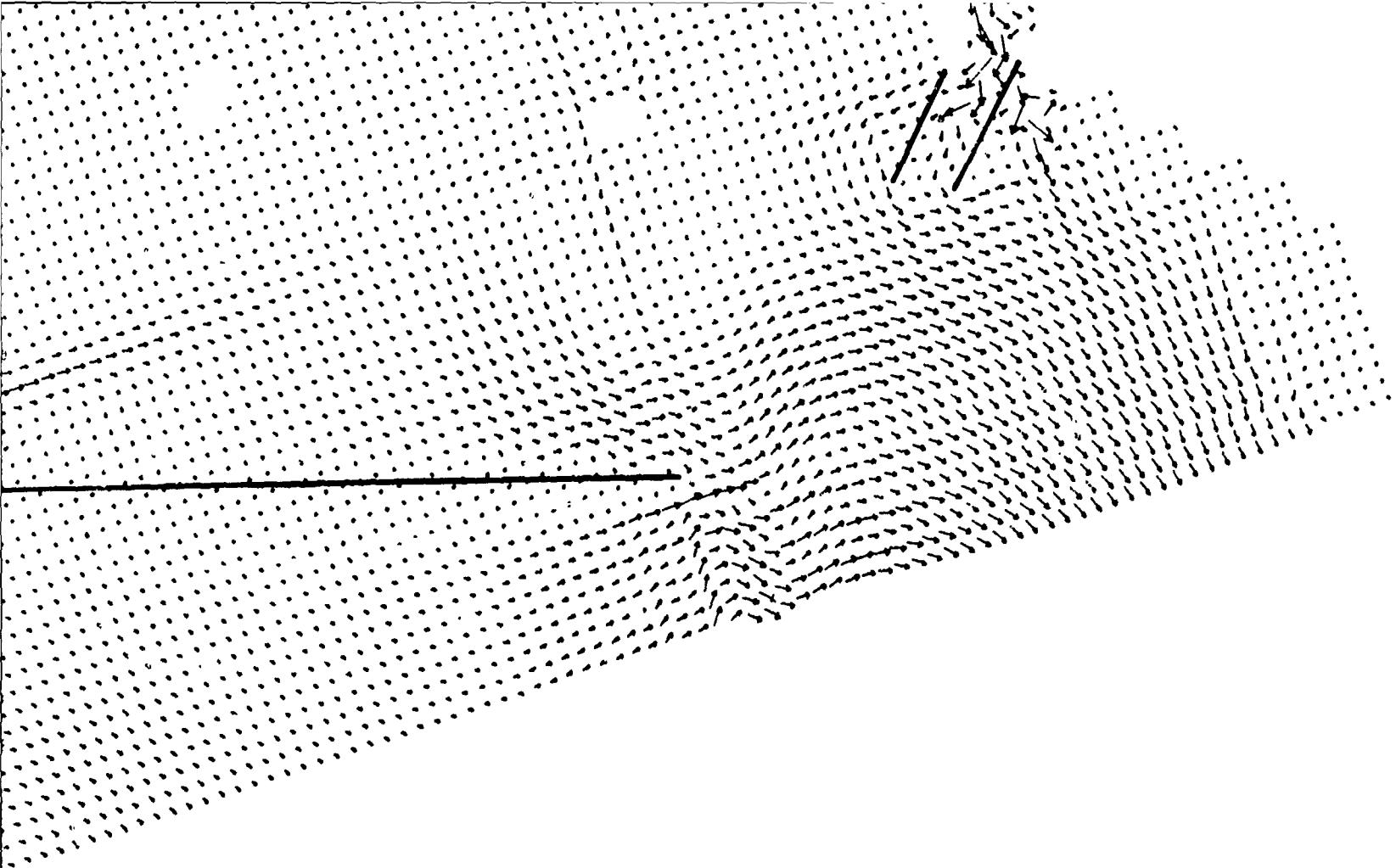


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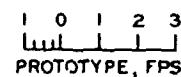
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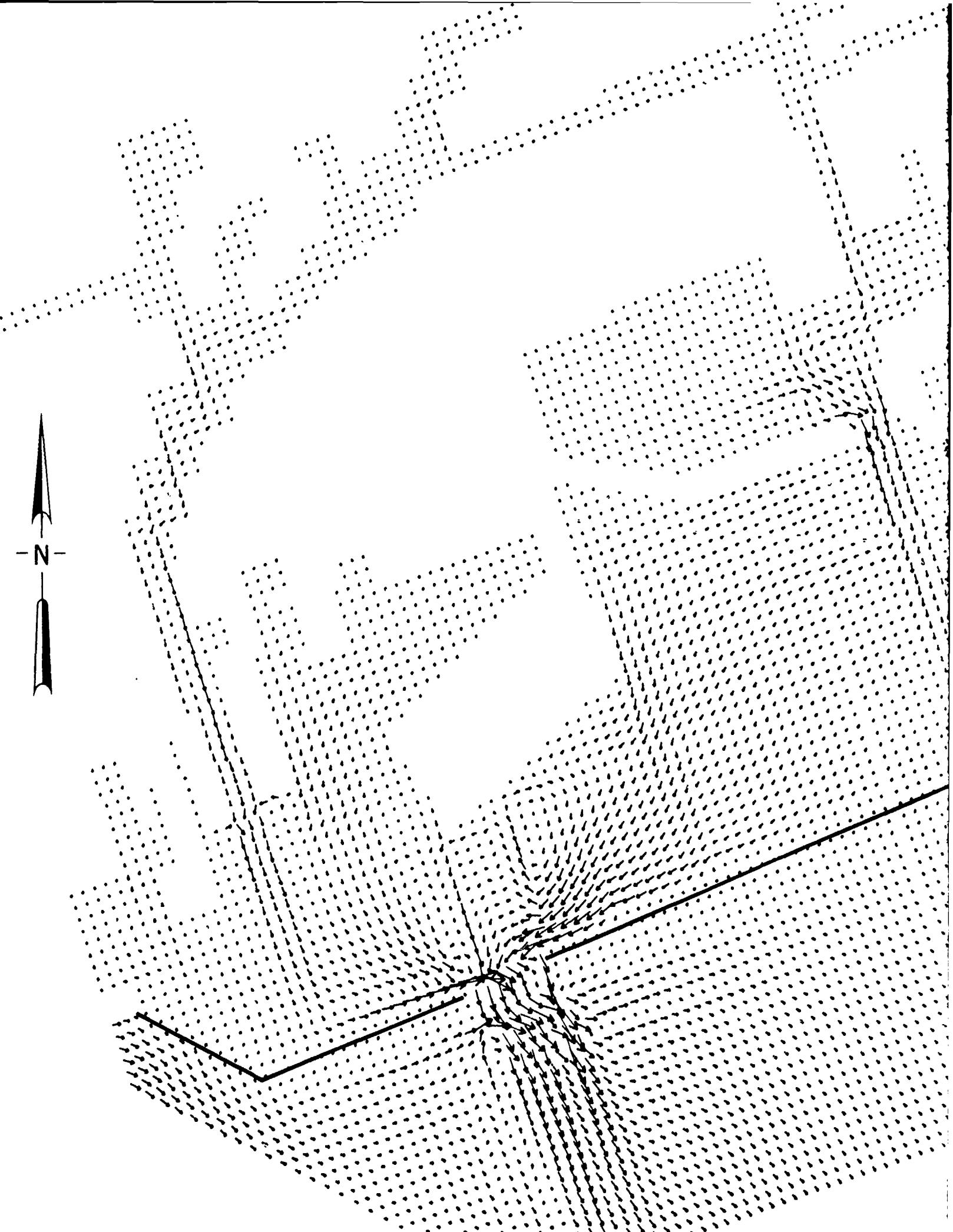
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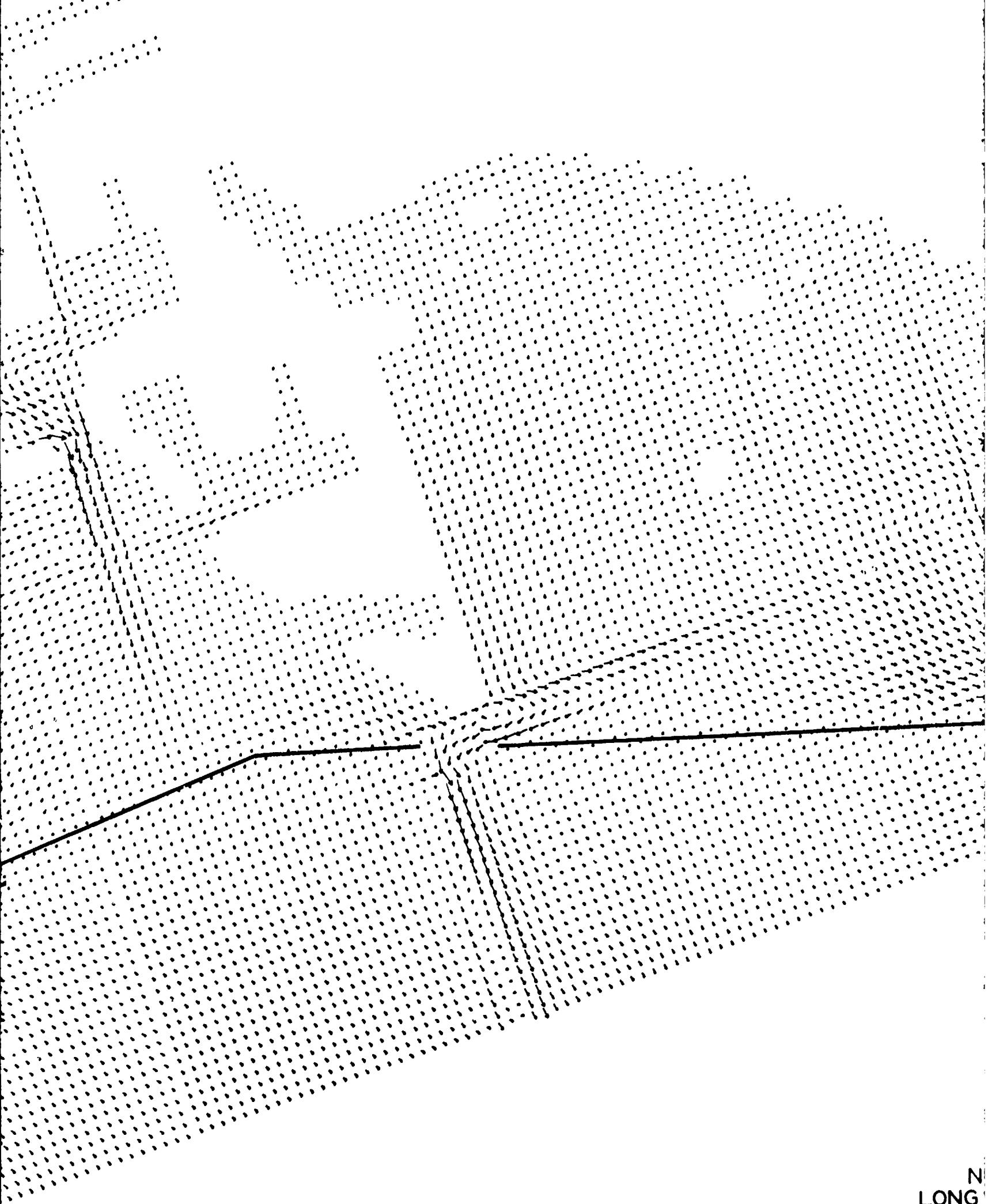


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LONG BEACH - LOS ANGELES HARBORS

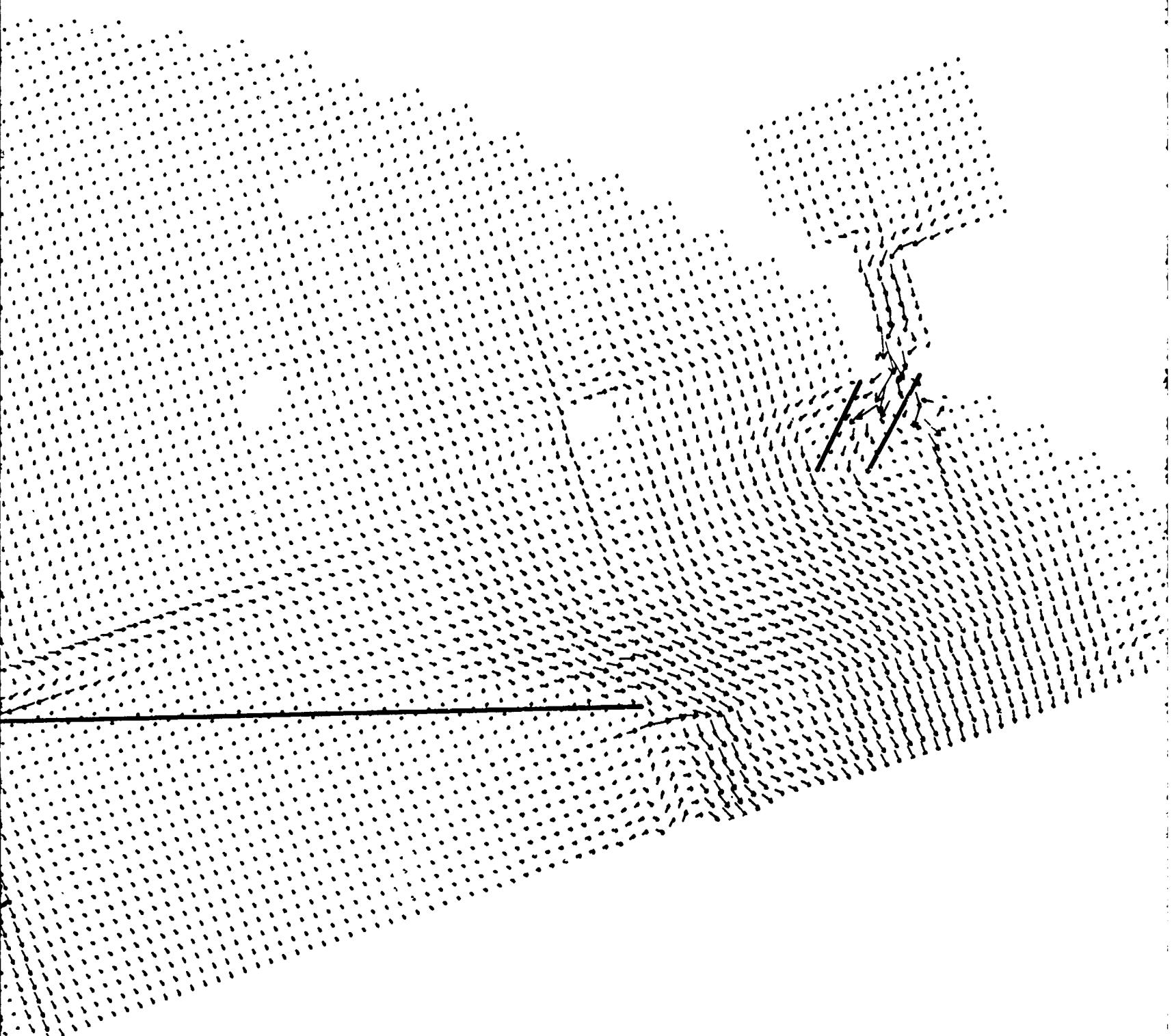
SURFACE CURRENT PATTERNS

PLAN 1A-2
SPRING TIDE
HOUR 22

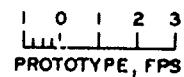




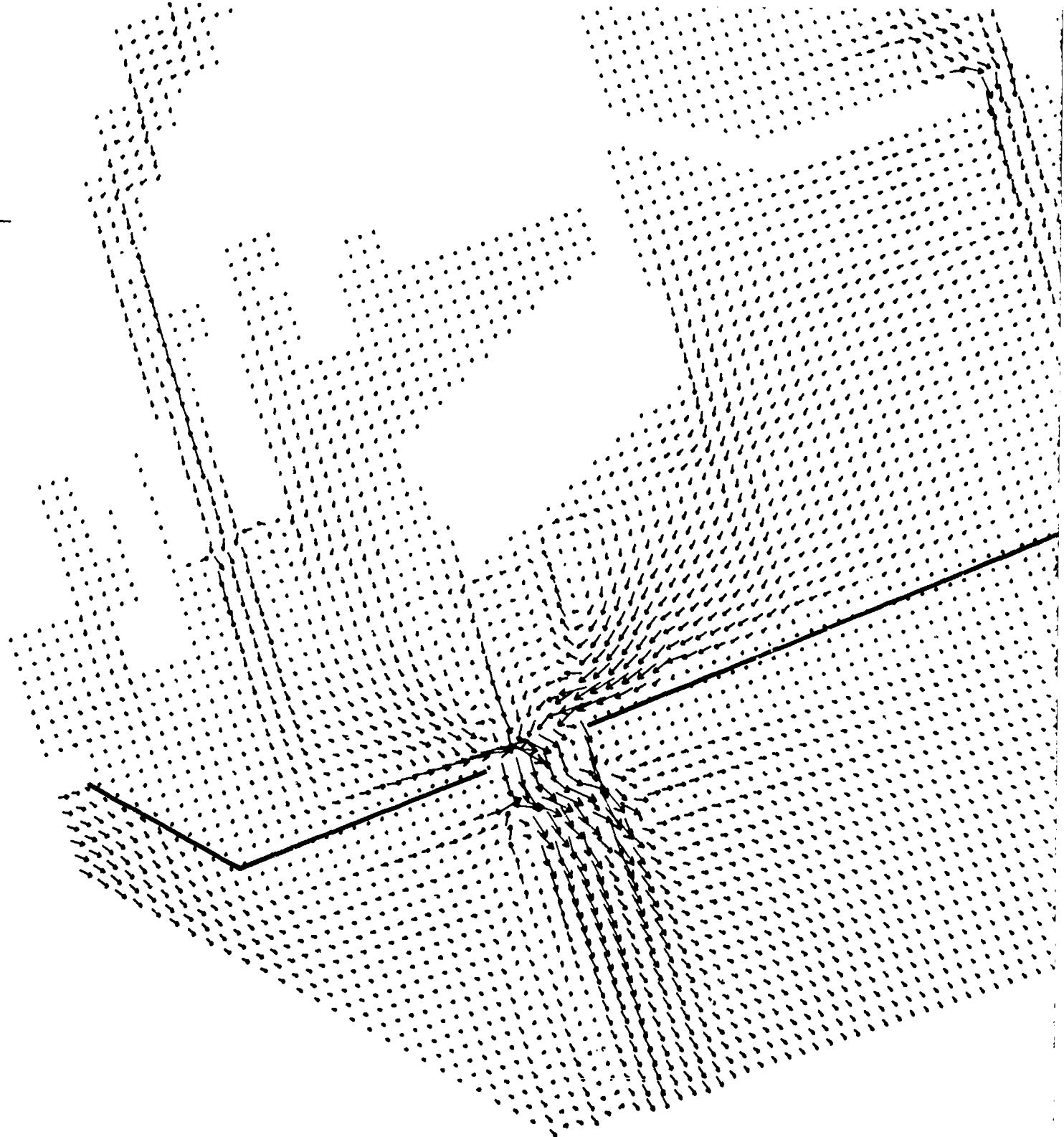
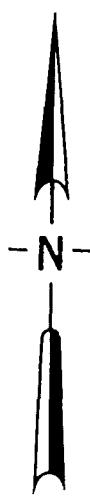
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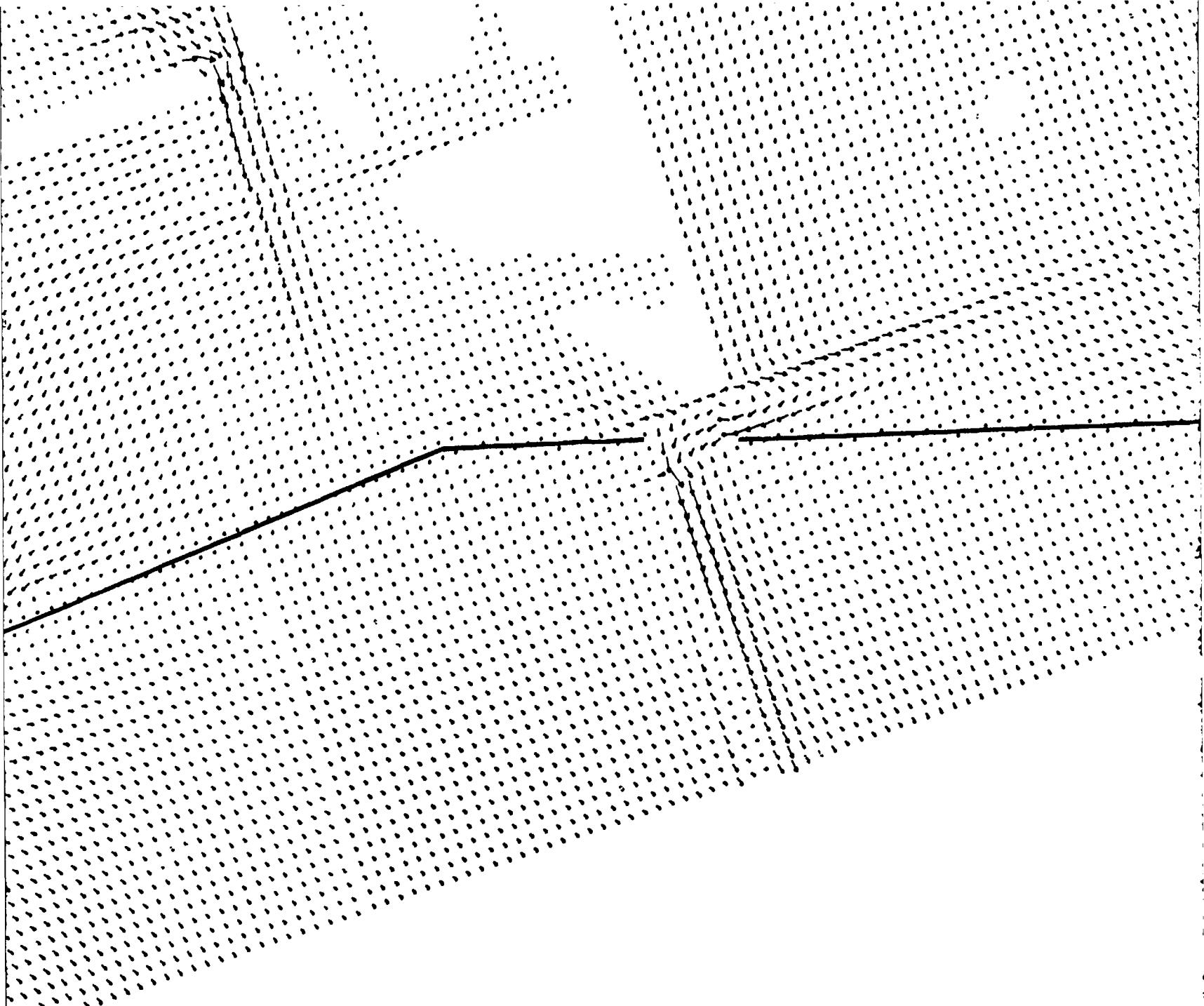


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

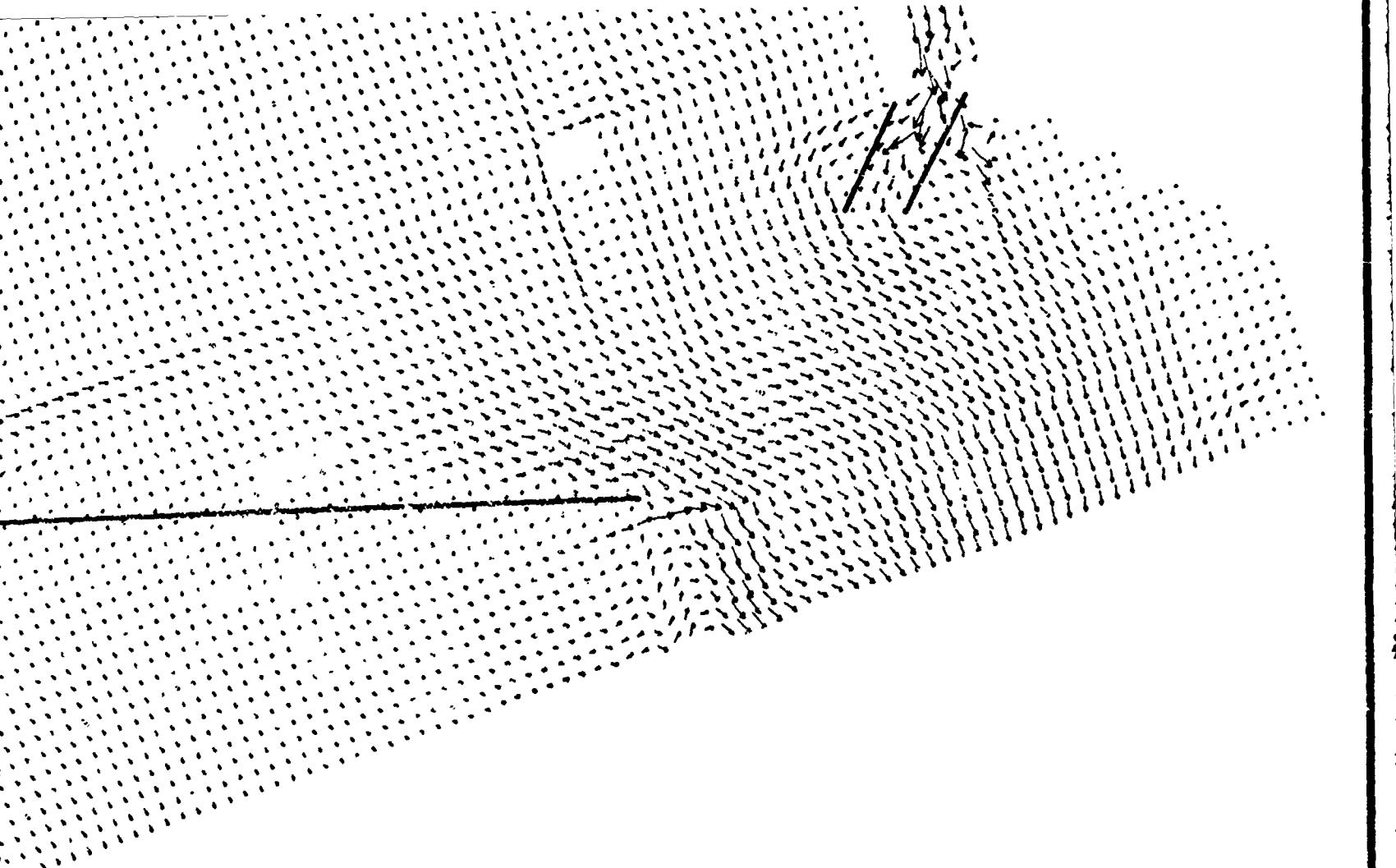




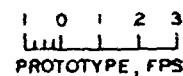
SCALE IN FEET

2000 0 2000 4000

SUF



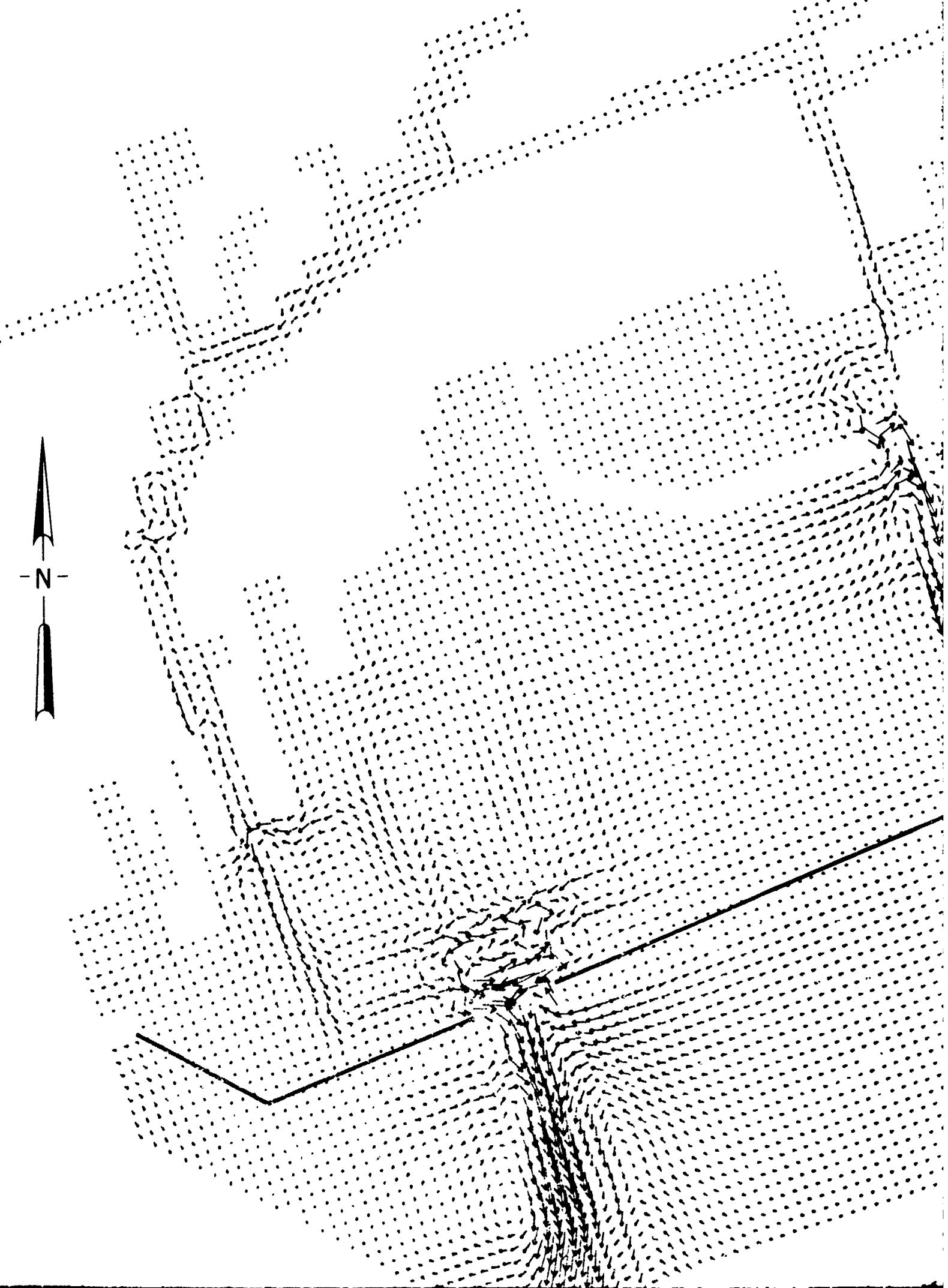
VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

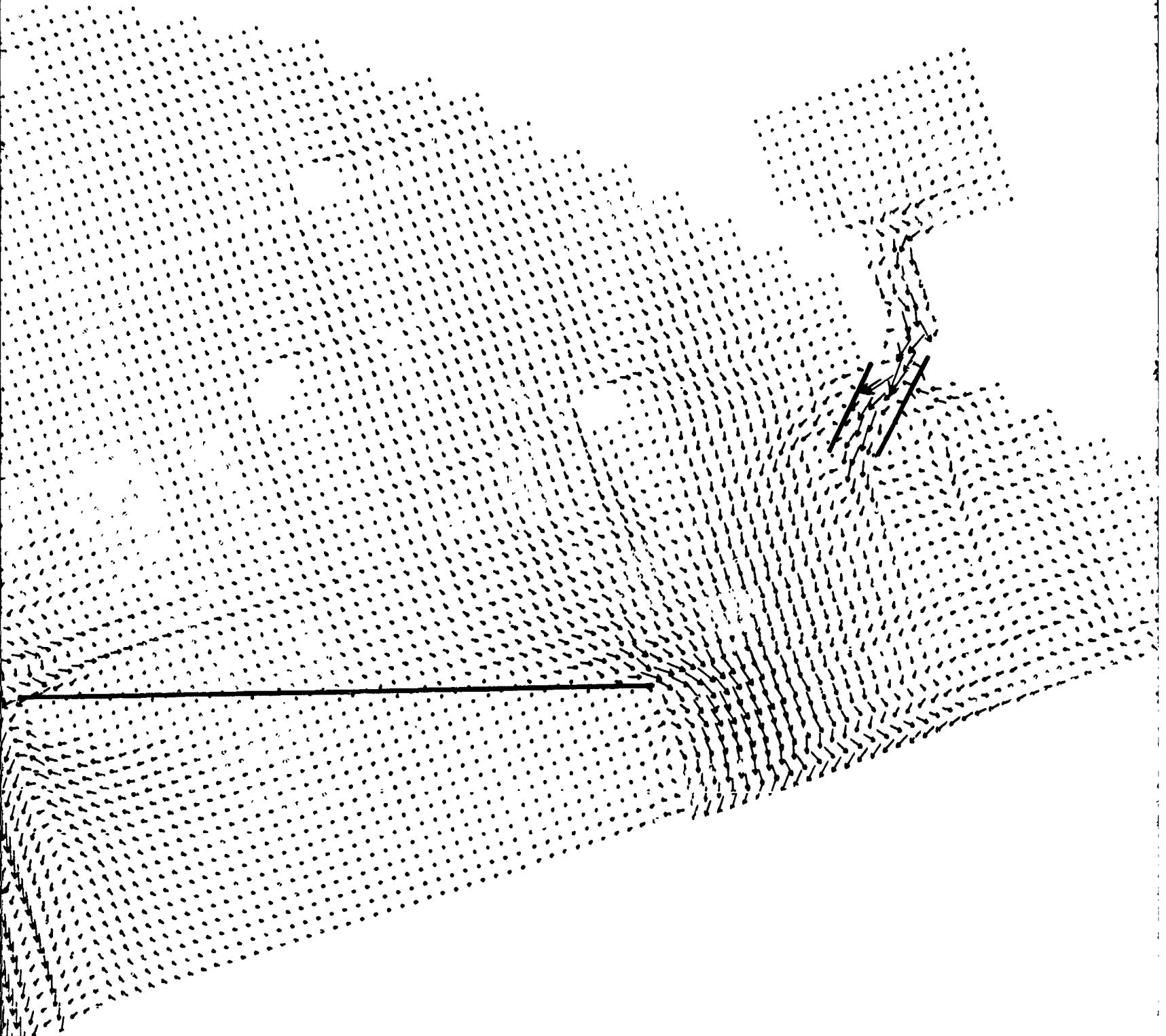
PLAN 1A-2
SPRING TIDE
HOUR 24





NUM
LONG BE

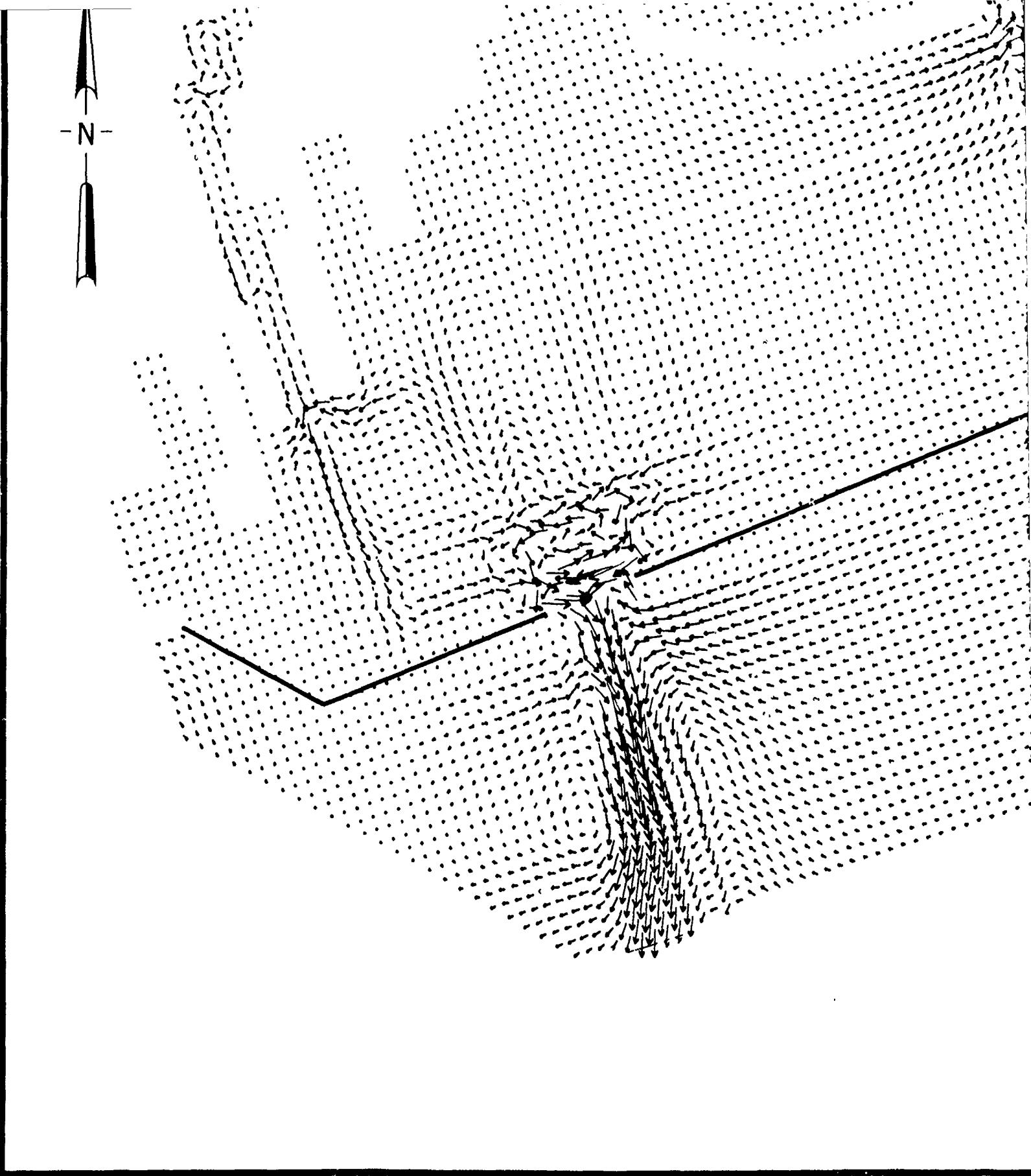
SURFACE



VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

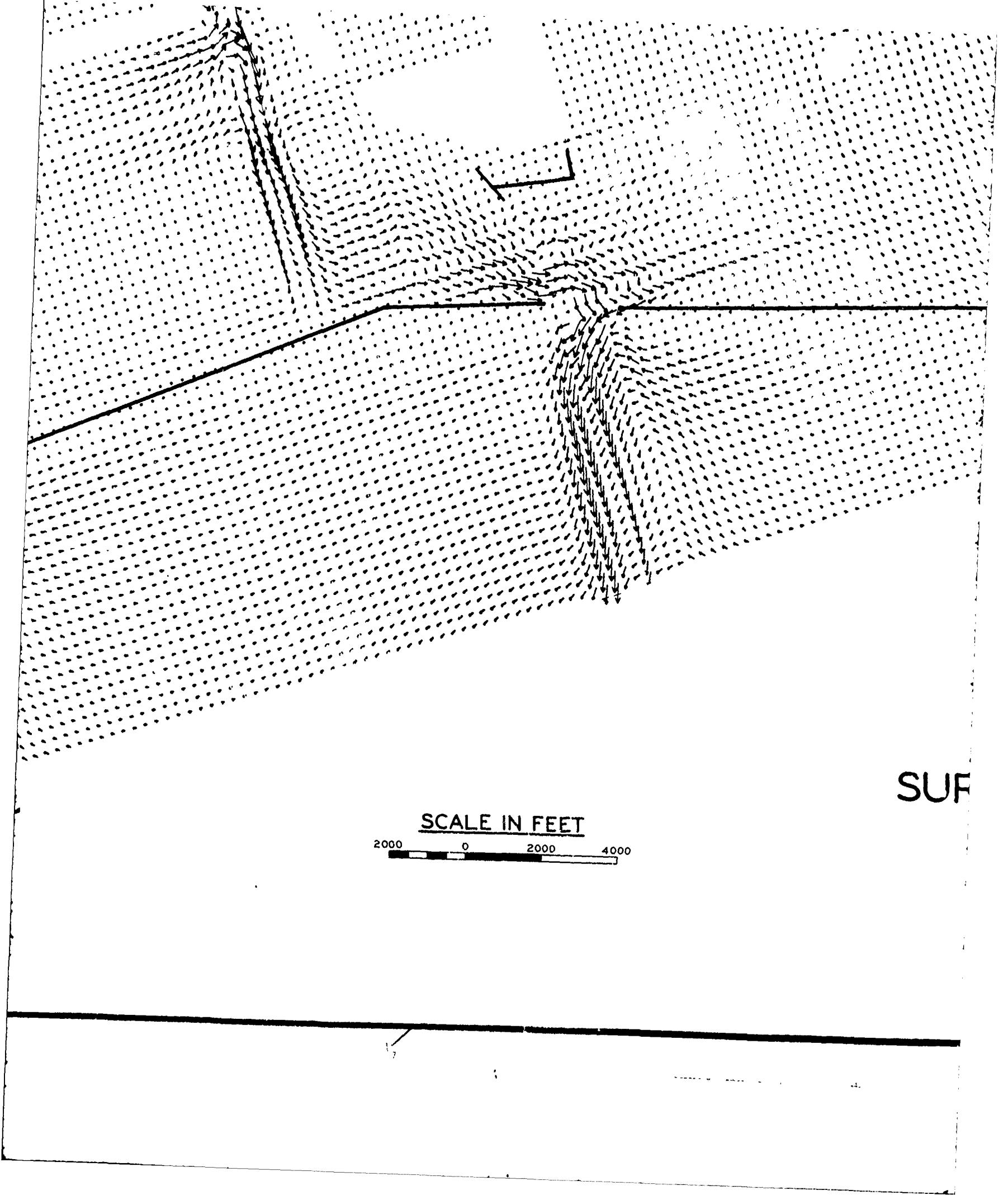
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS



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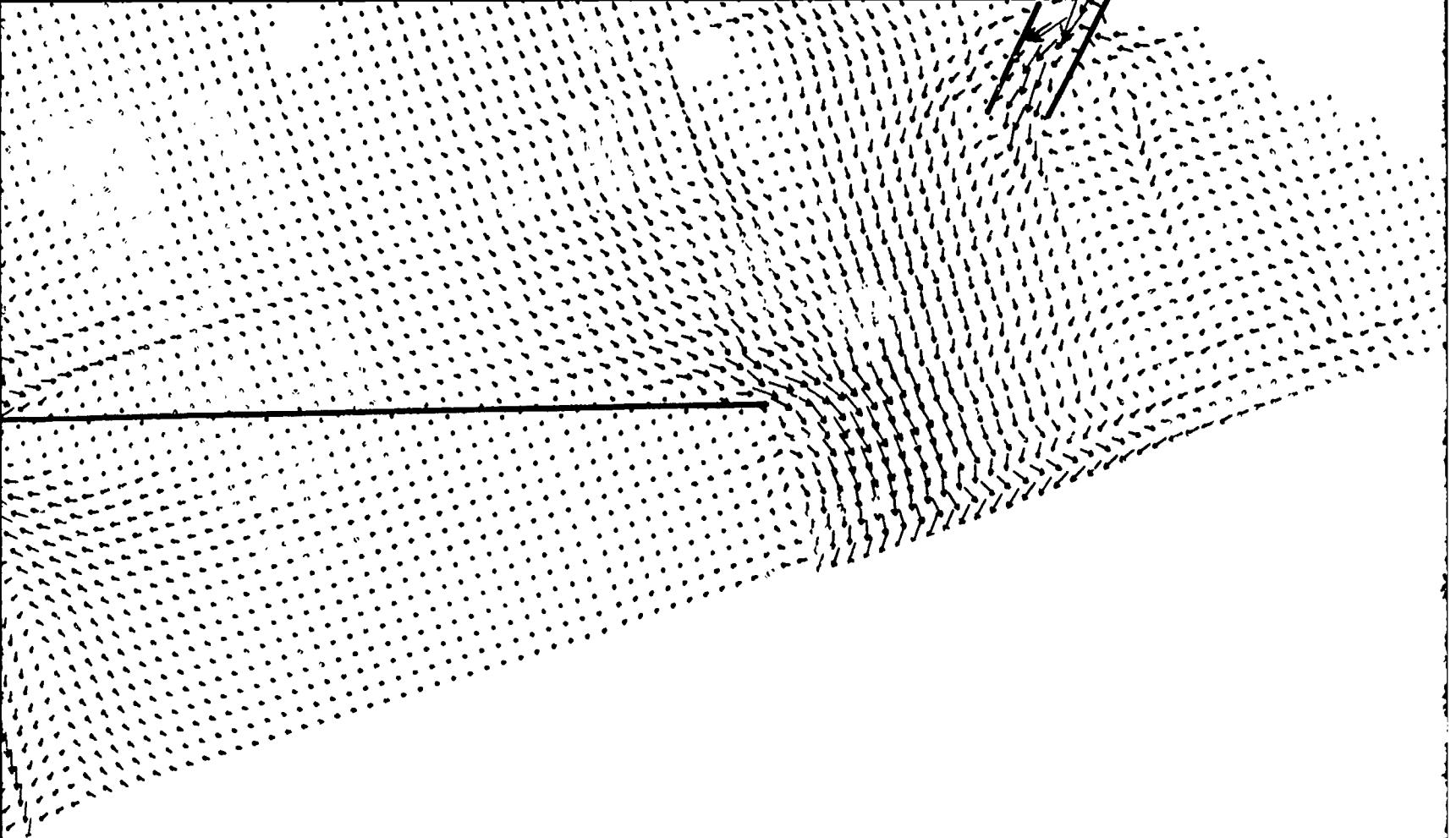
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SCALE IN FEET

2000 0 2000 4000



VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

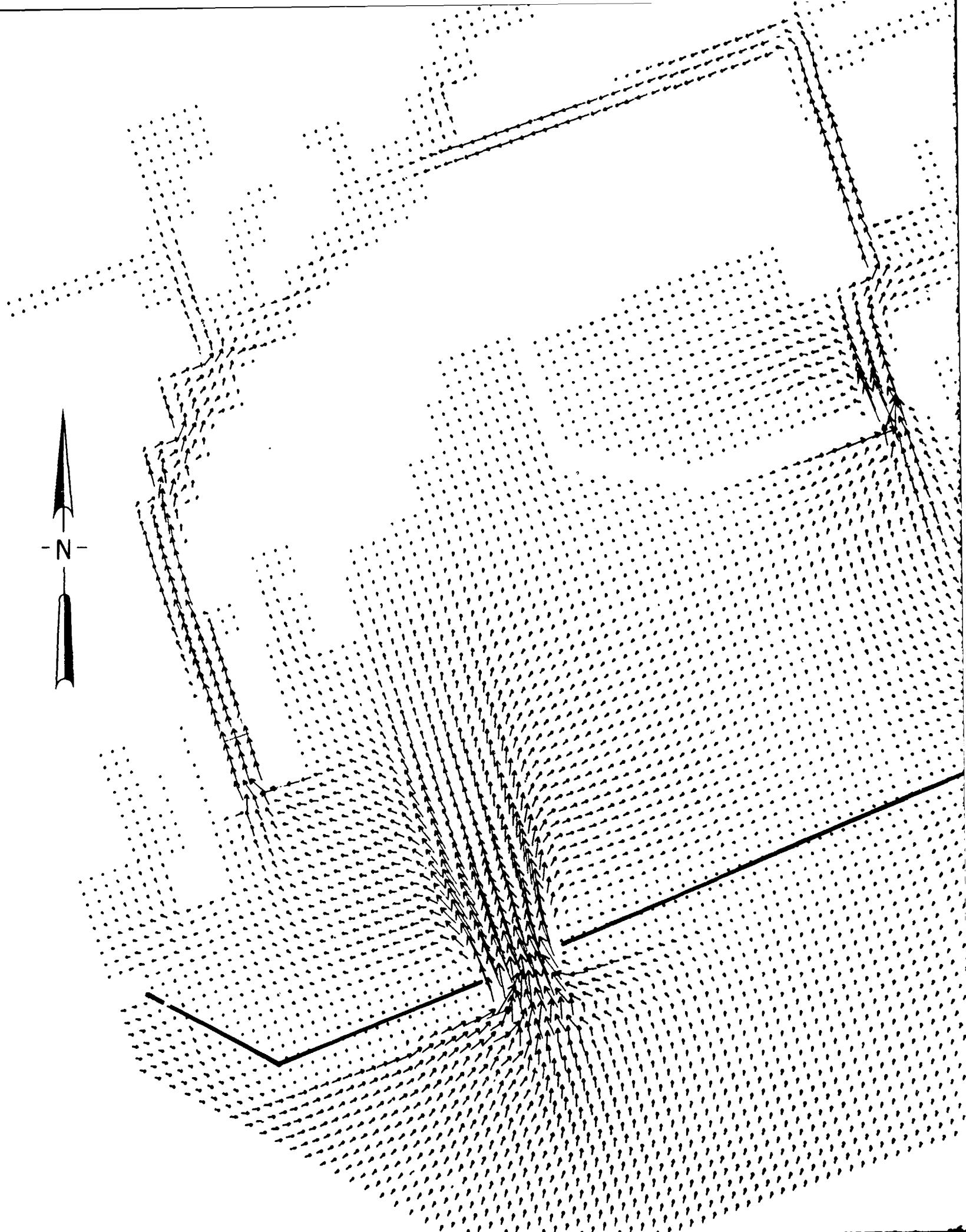
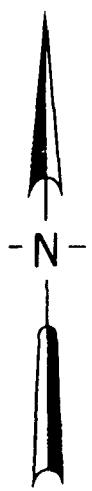
SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
-82-FT CHANNEL

SPRING TIDE
HOUR 15

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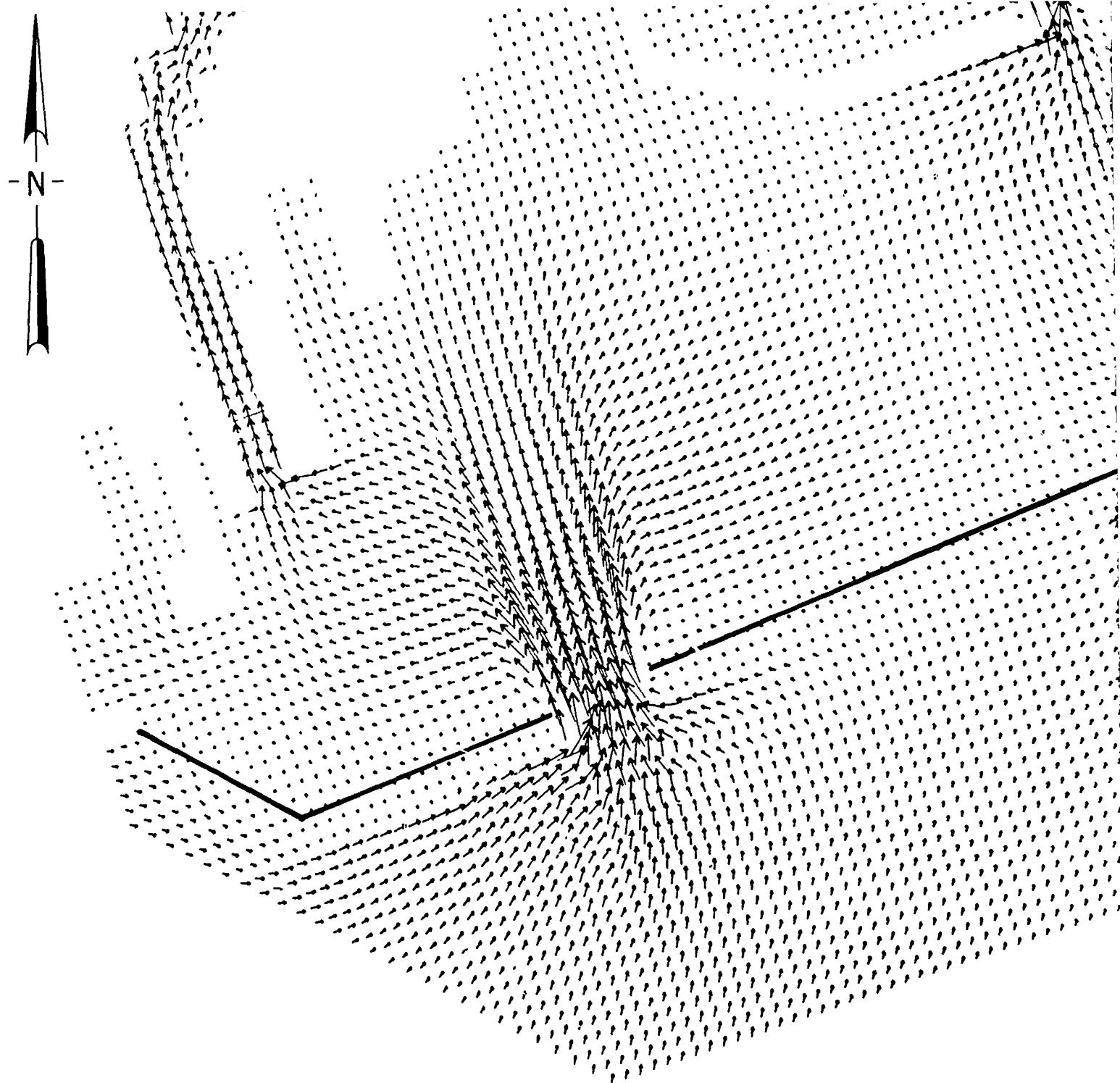


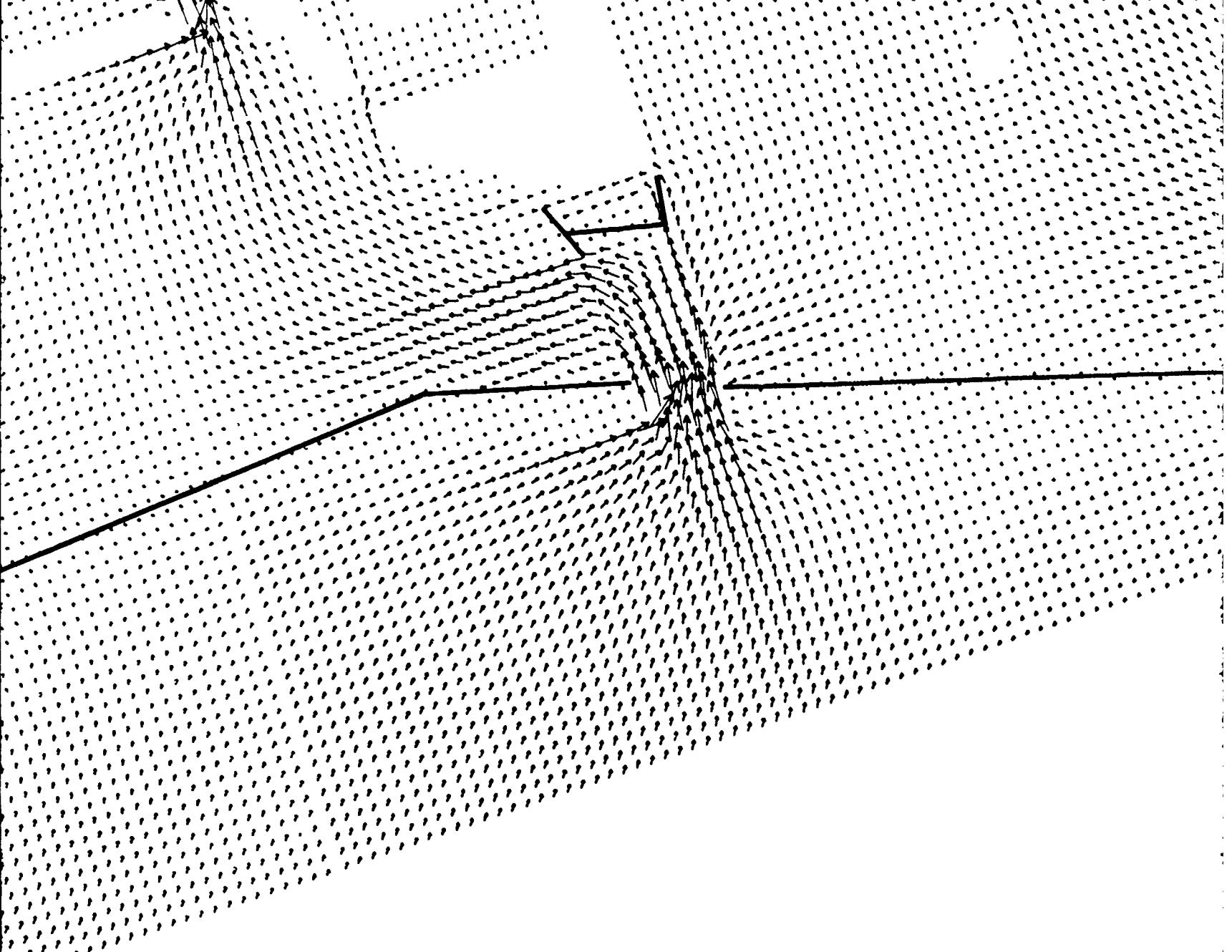




NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS



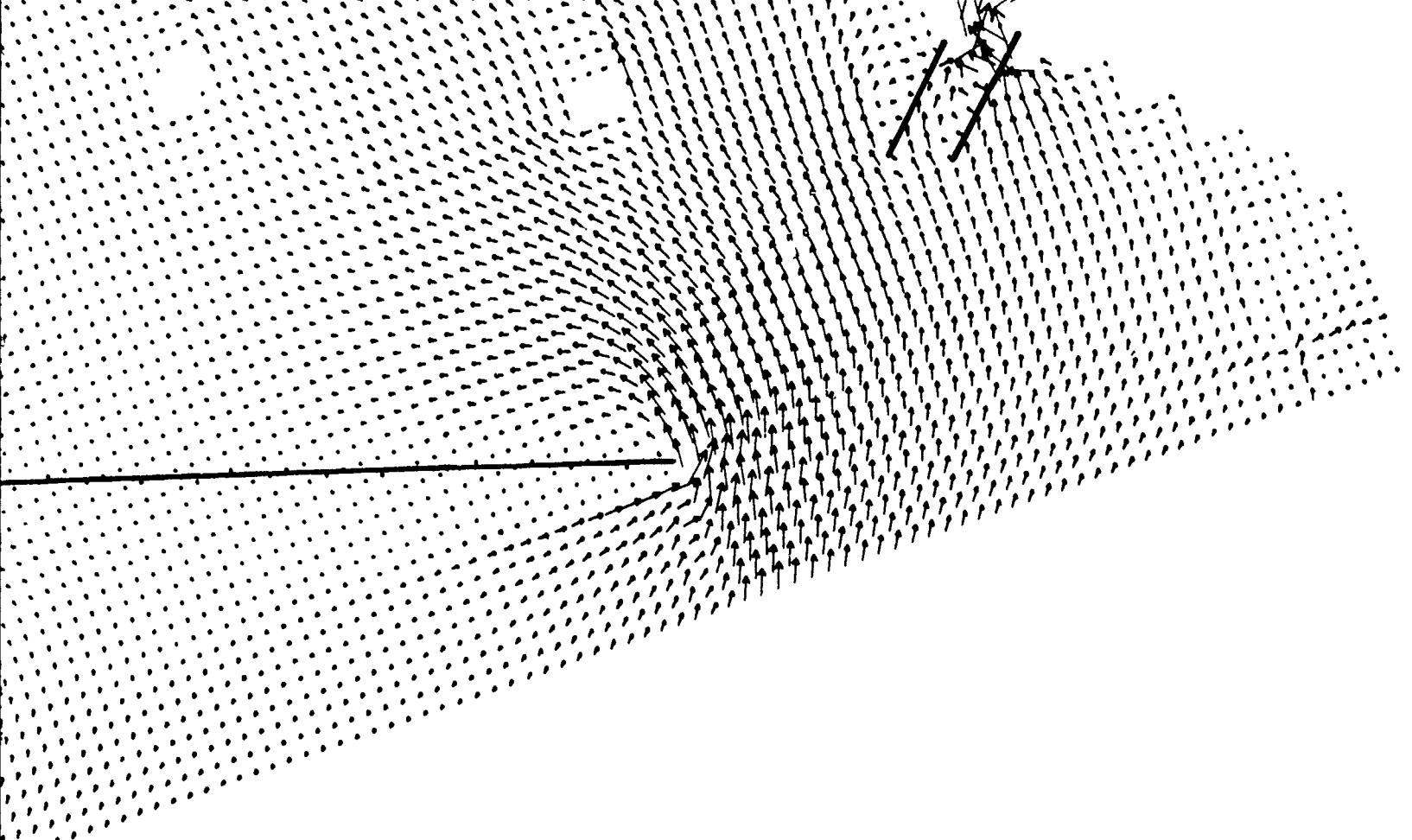


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SCALE IN FEET

2000 0 2000 4000

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VELOCITY SCALE

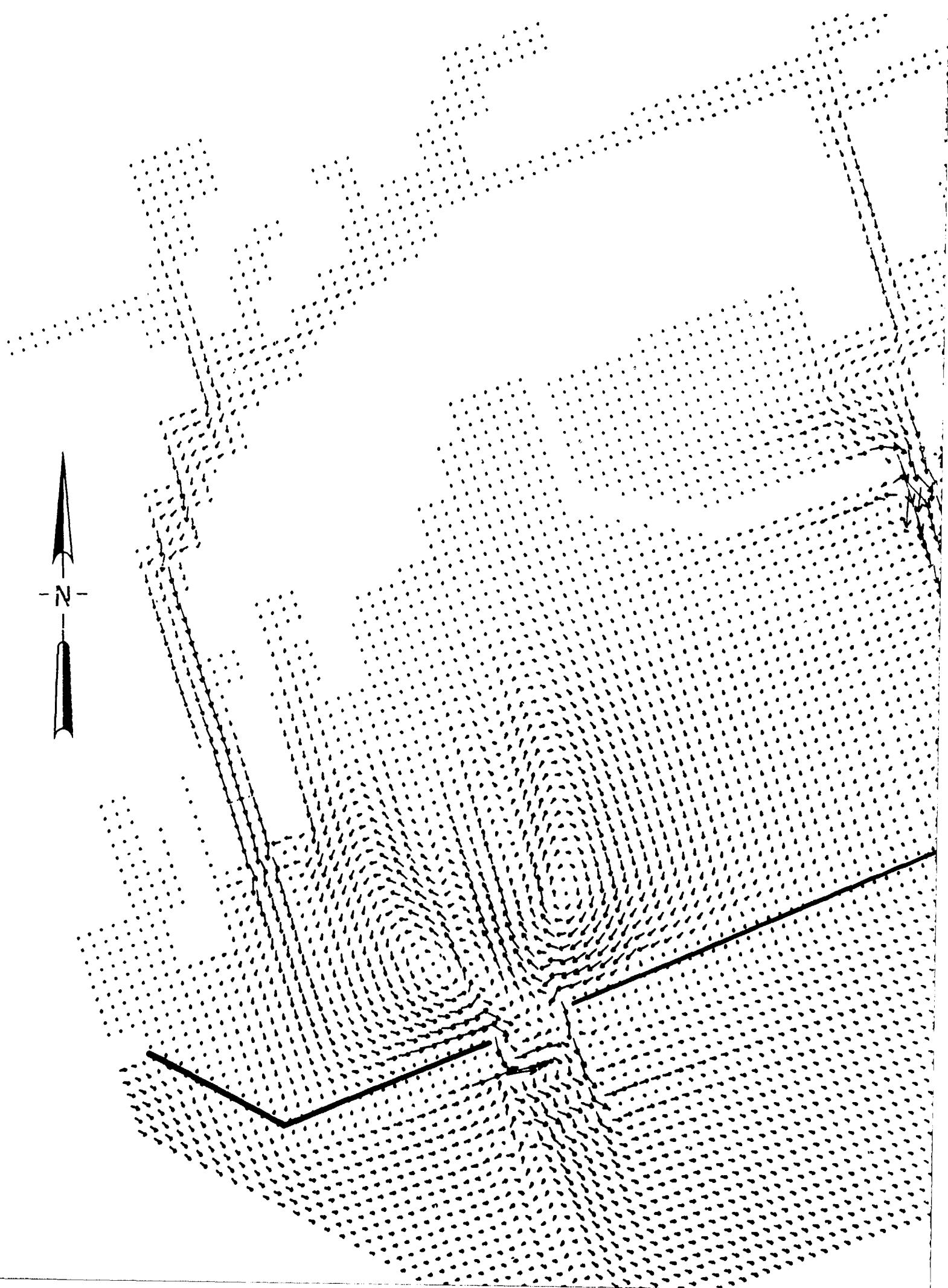


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

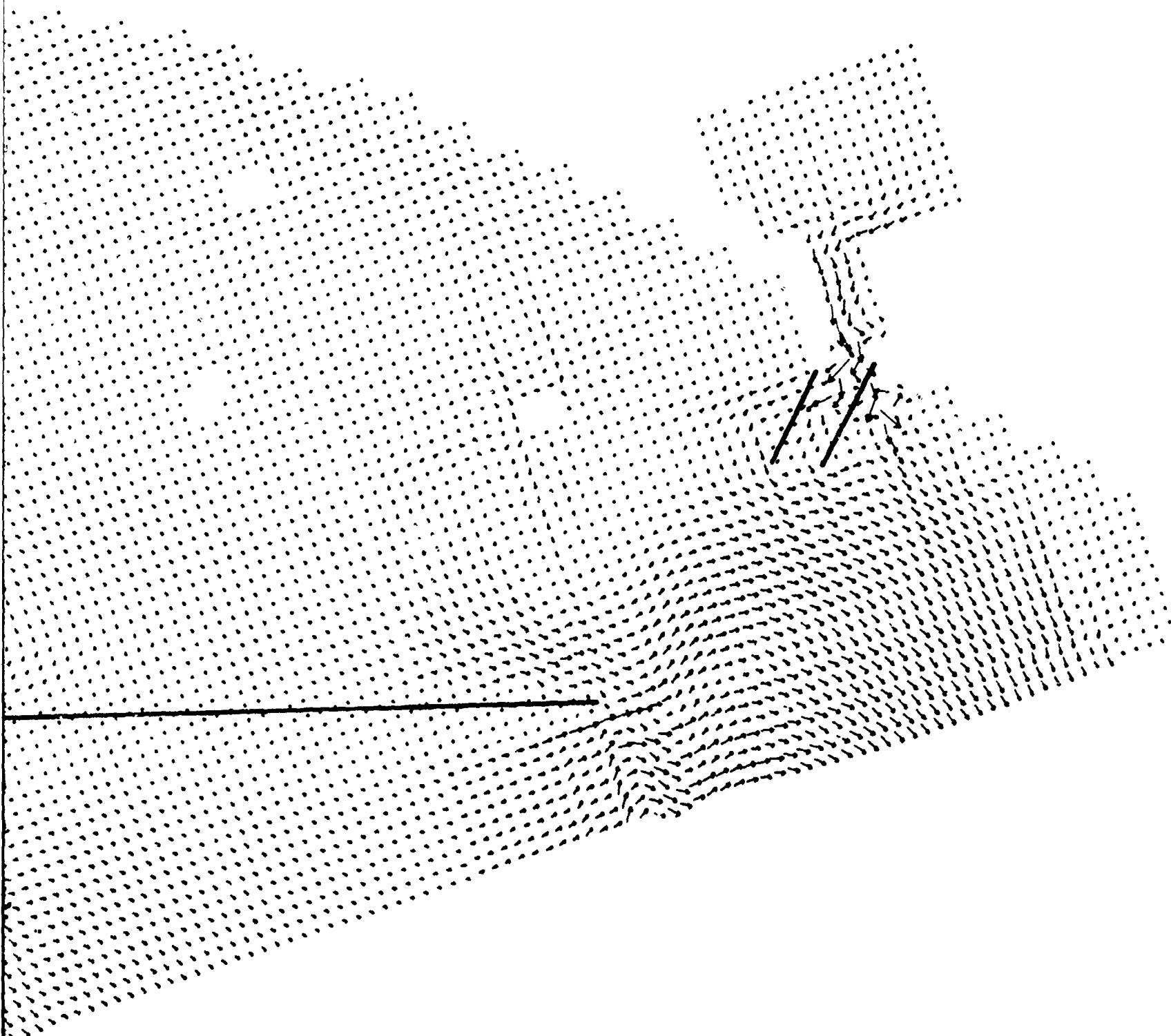
SCHEME STFP 2, 300-FT OPENING
-82-FT CHANNEL

SPRING TIDE
HOUR 19

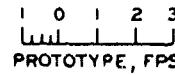




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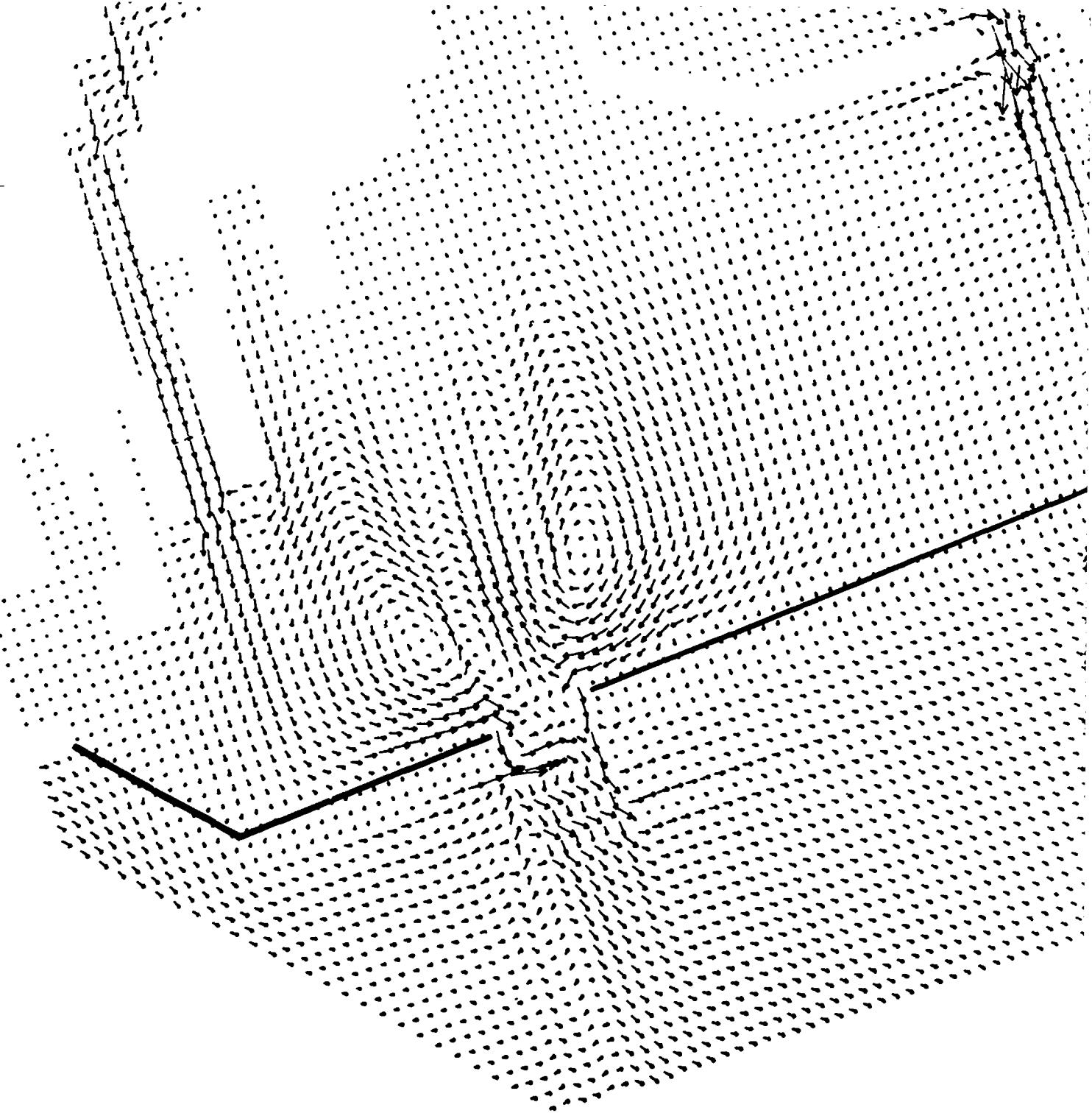
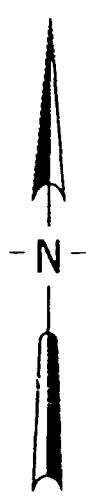


VELOCITY SCALE



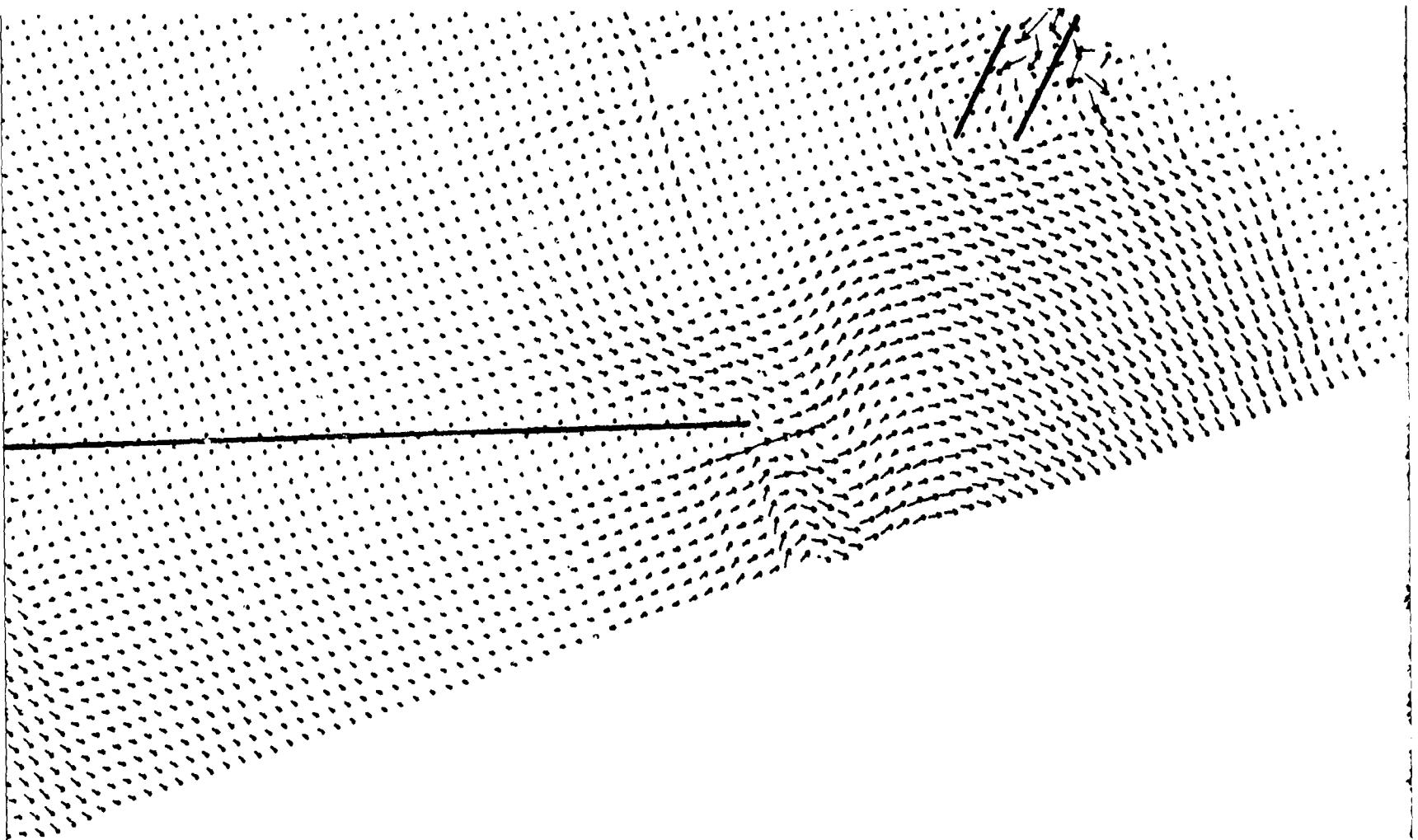
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

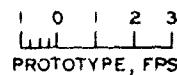


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SCALE IN FEET
2000 0 2000 4000



VELOCITY SCALE

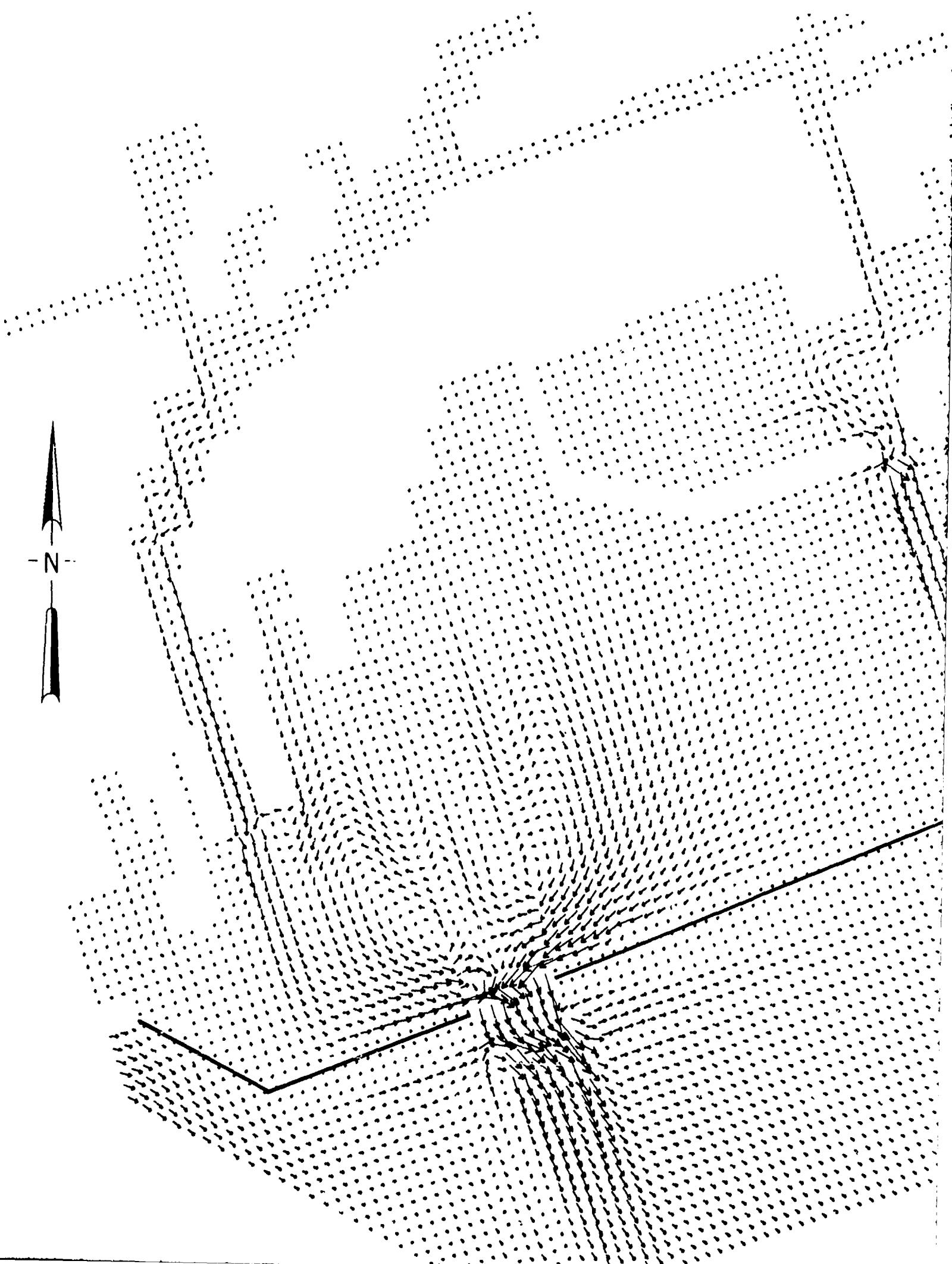


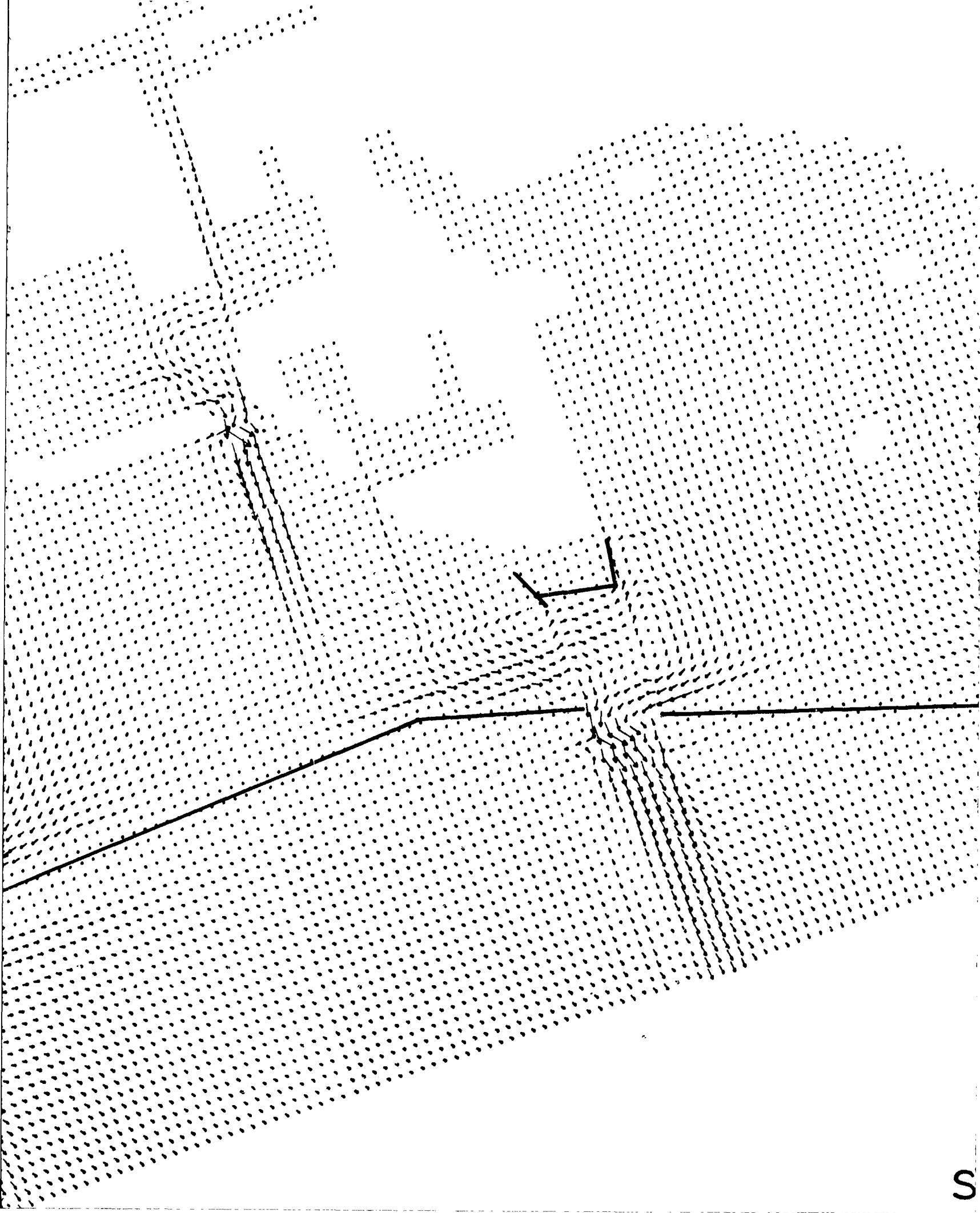
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LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

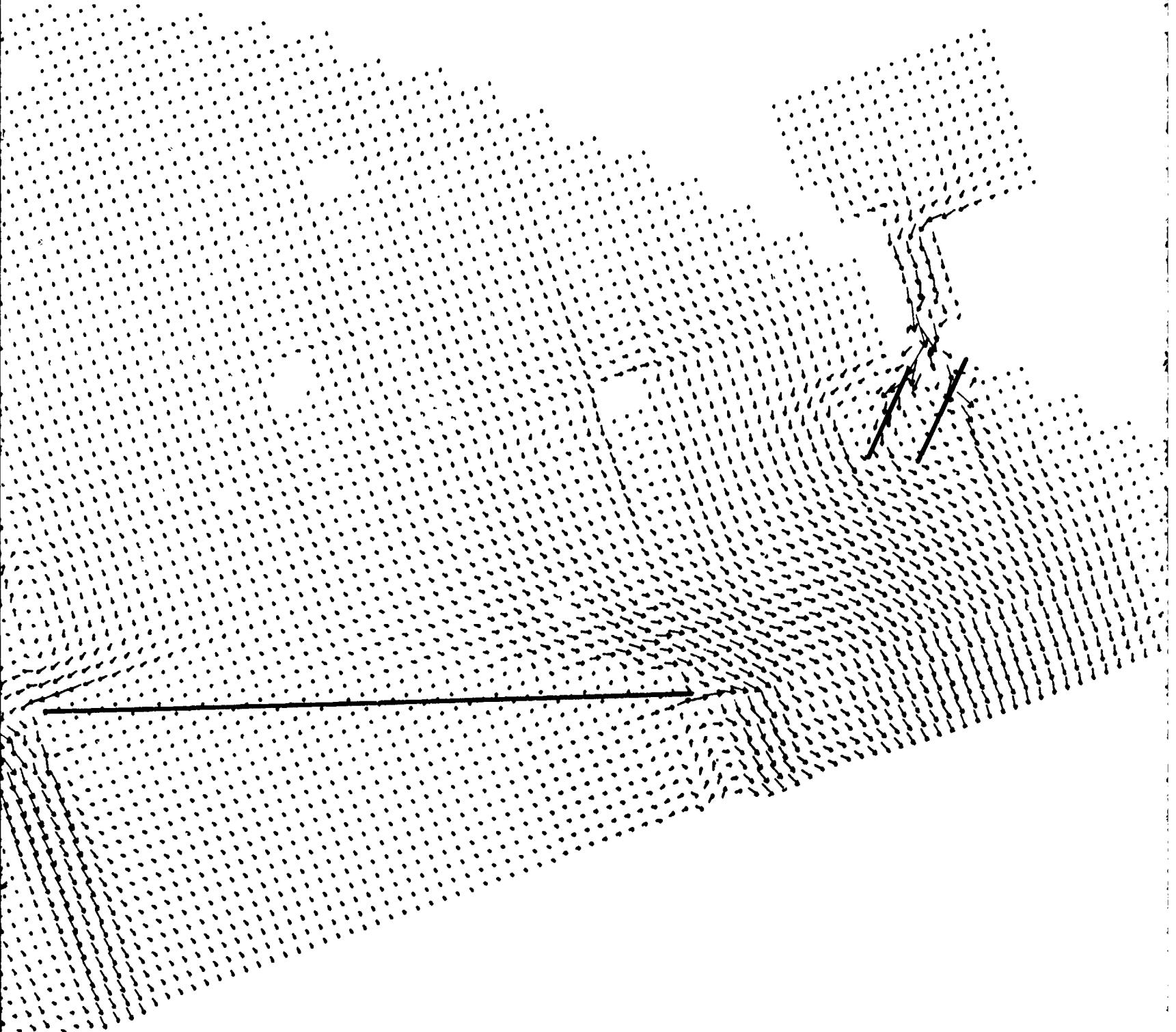
SCHEME STFP 2, 300-FT OPENING
- 82-FT CHANNEL

SPRING TIDE
HOUR 22

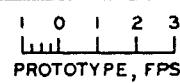




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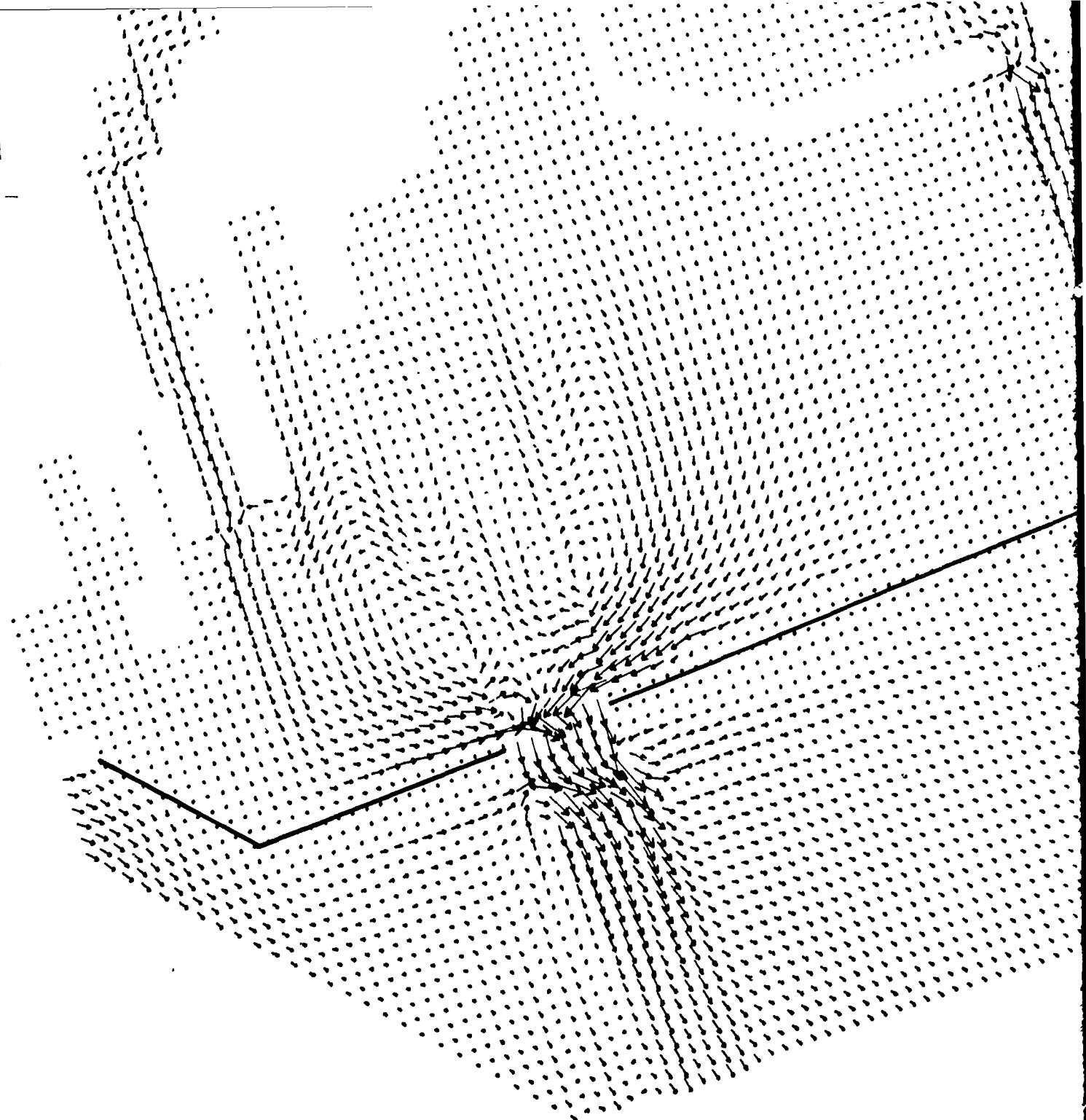
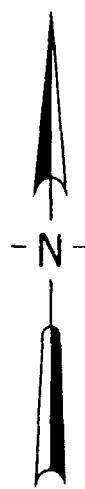


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

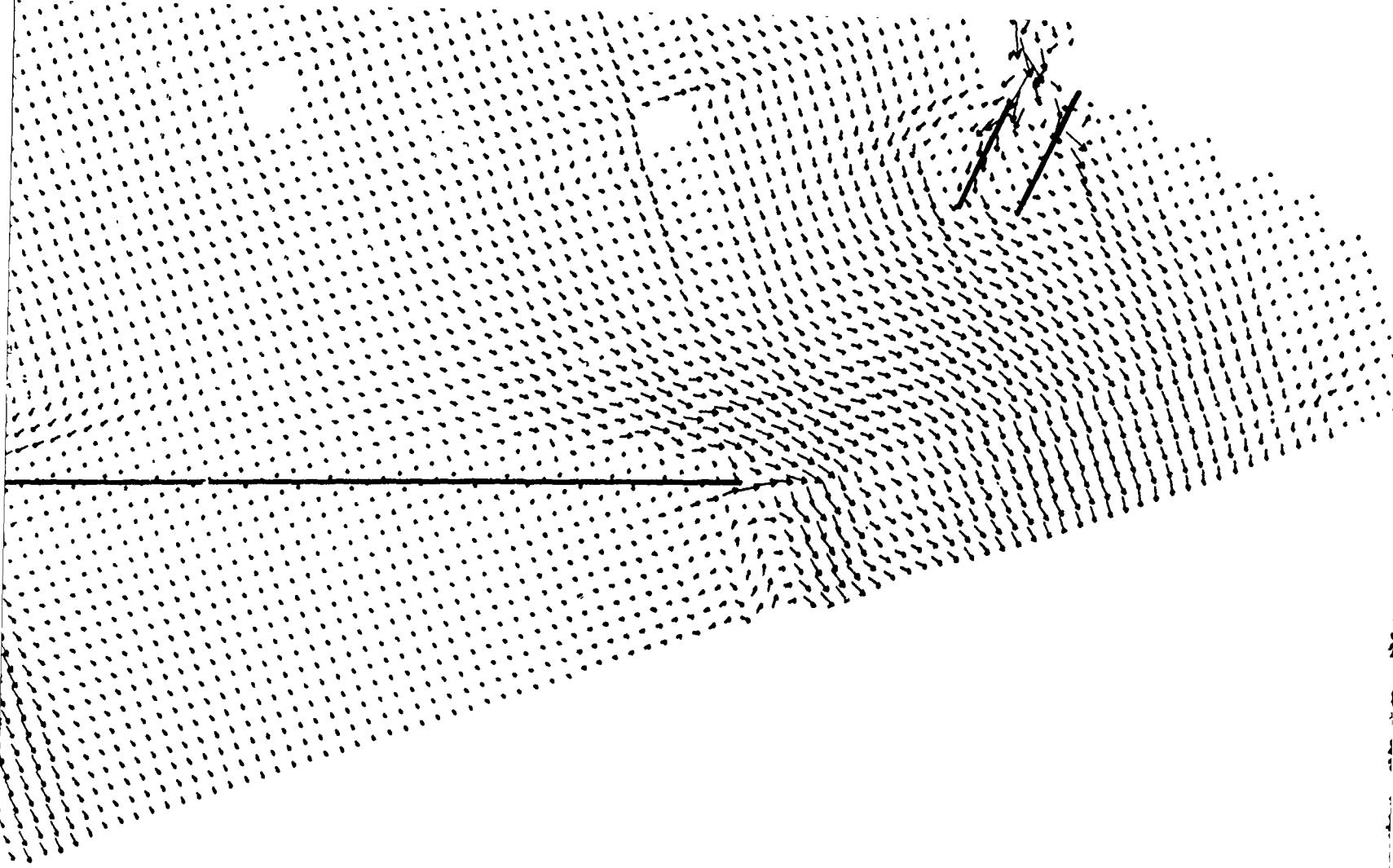


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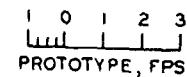
SURFACE
SCHEME

SCALE IN FEET

2000 0 2000 4000



VELOCITY SCALE

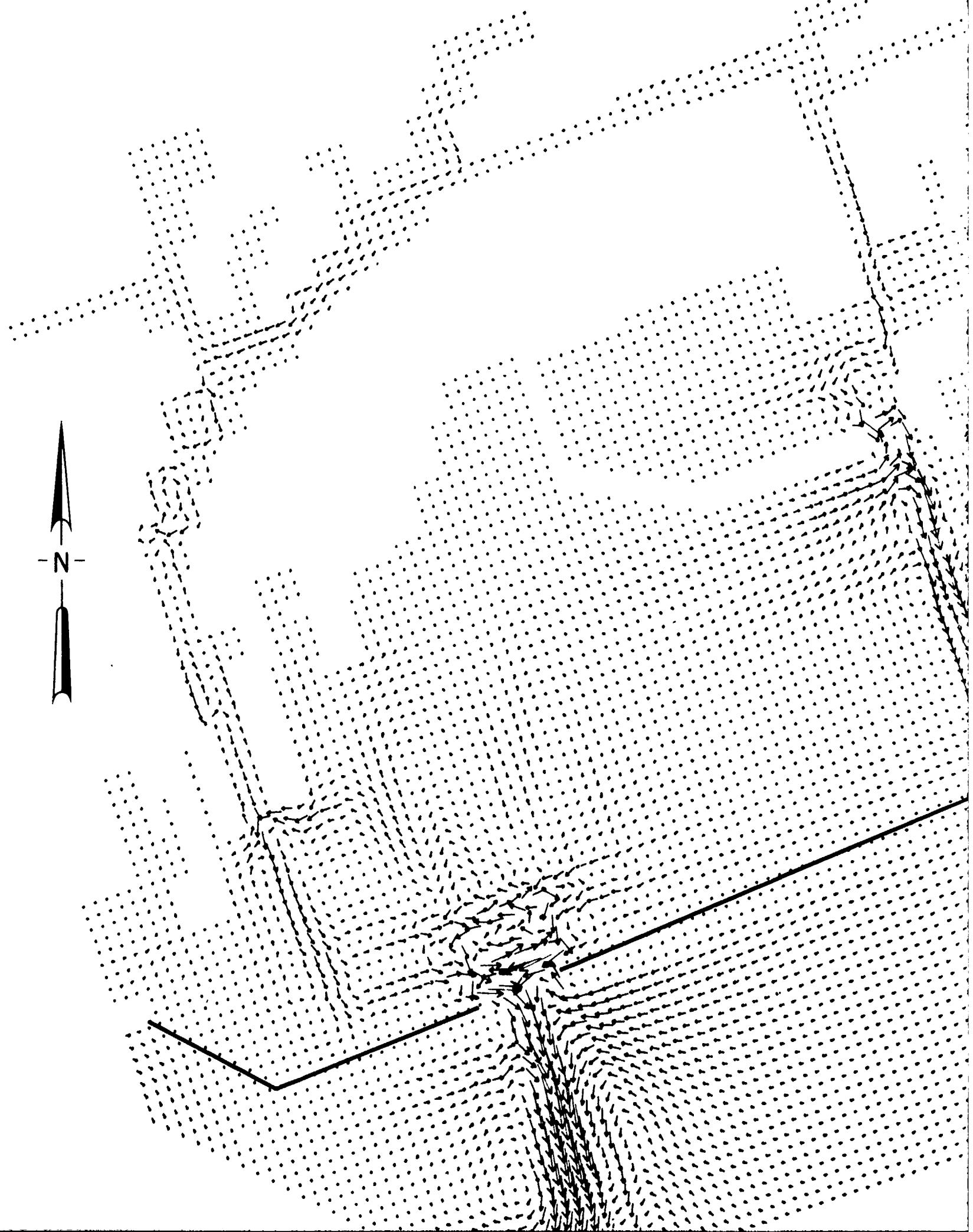


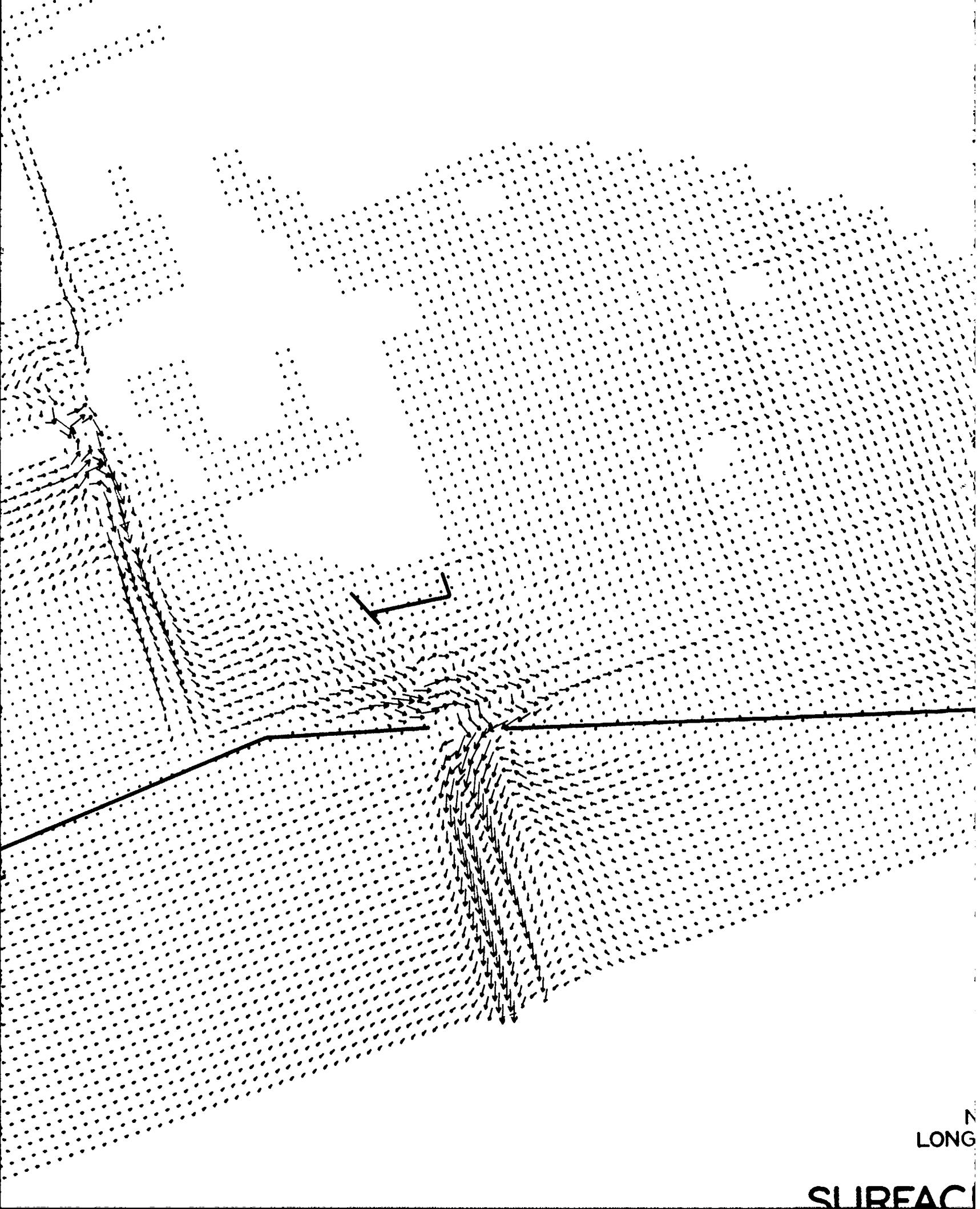
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 2, 300-FT OPENING
- 82 - FT CHANNEL

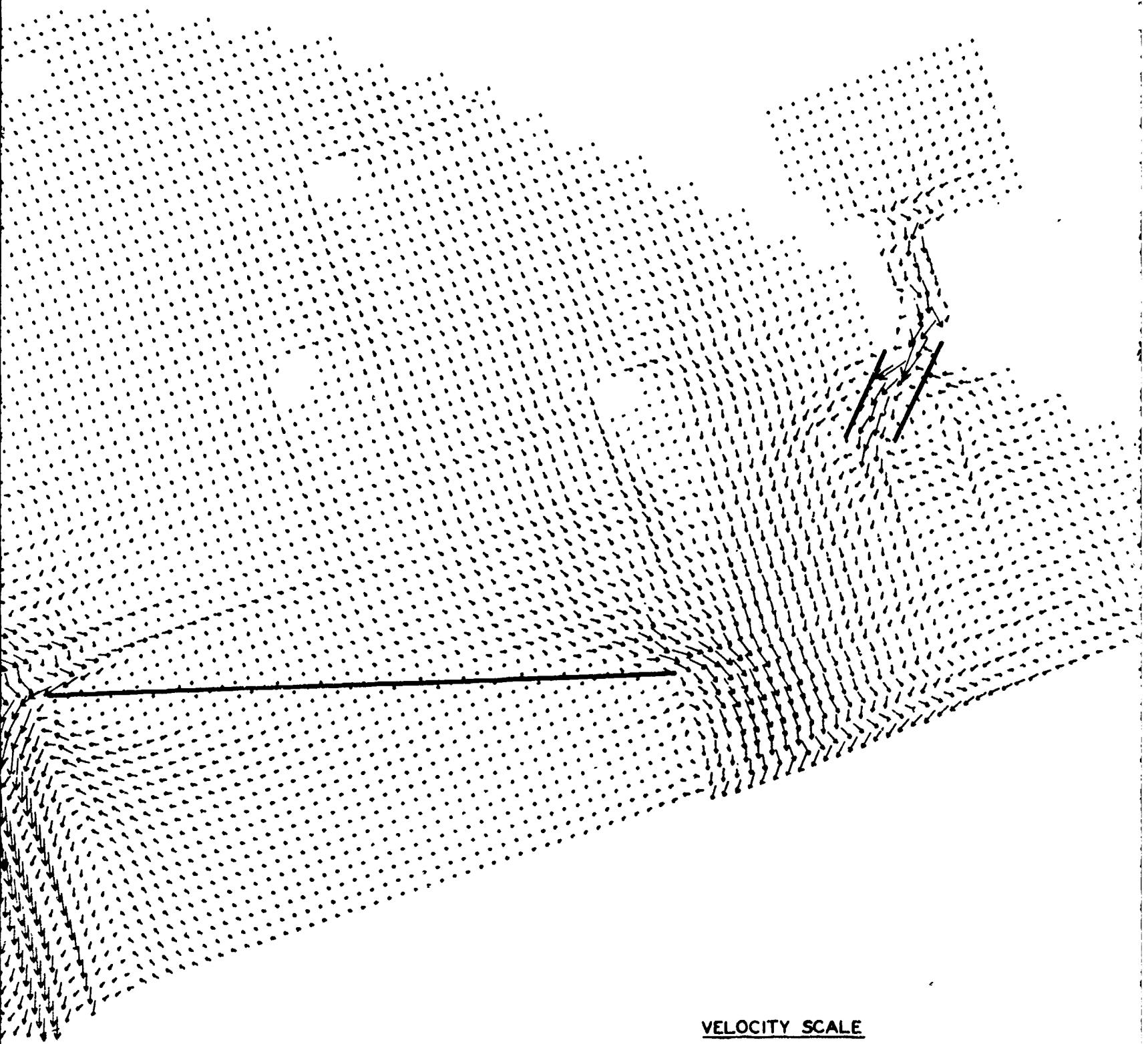
SPRING TIDE
HOUR 24



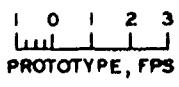


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LONG

SLIPFACE

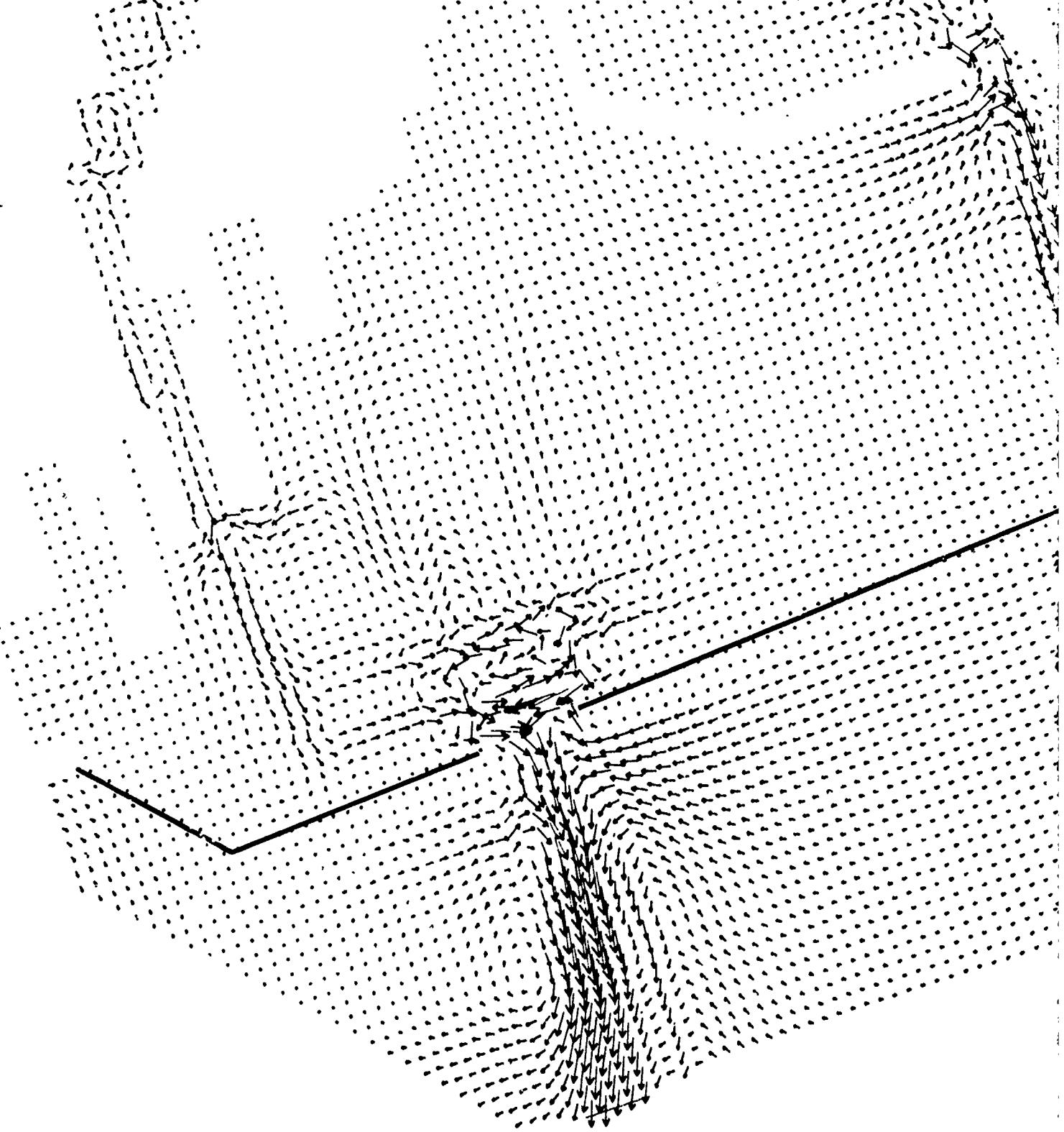
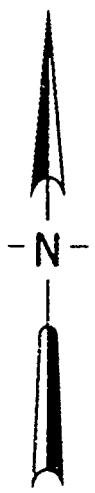


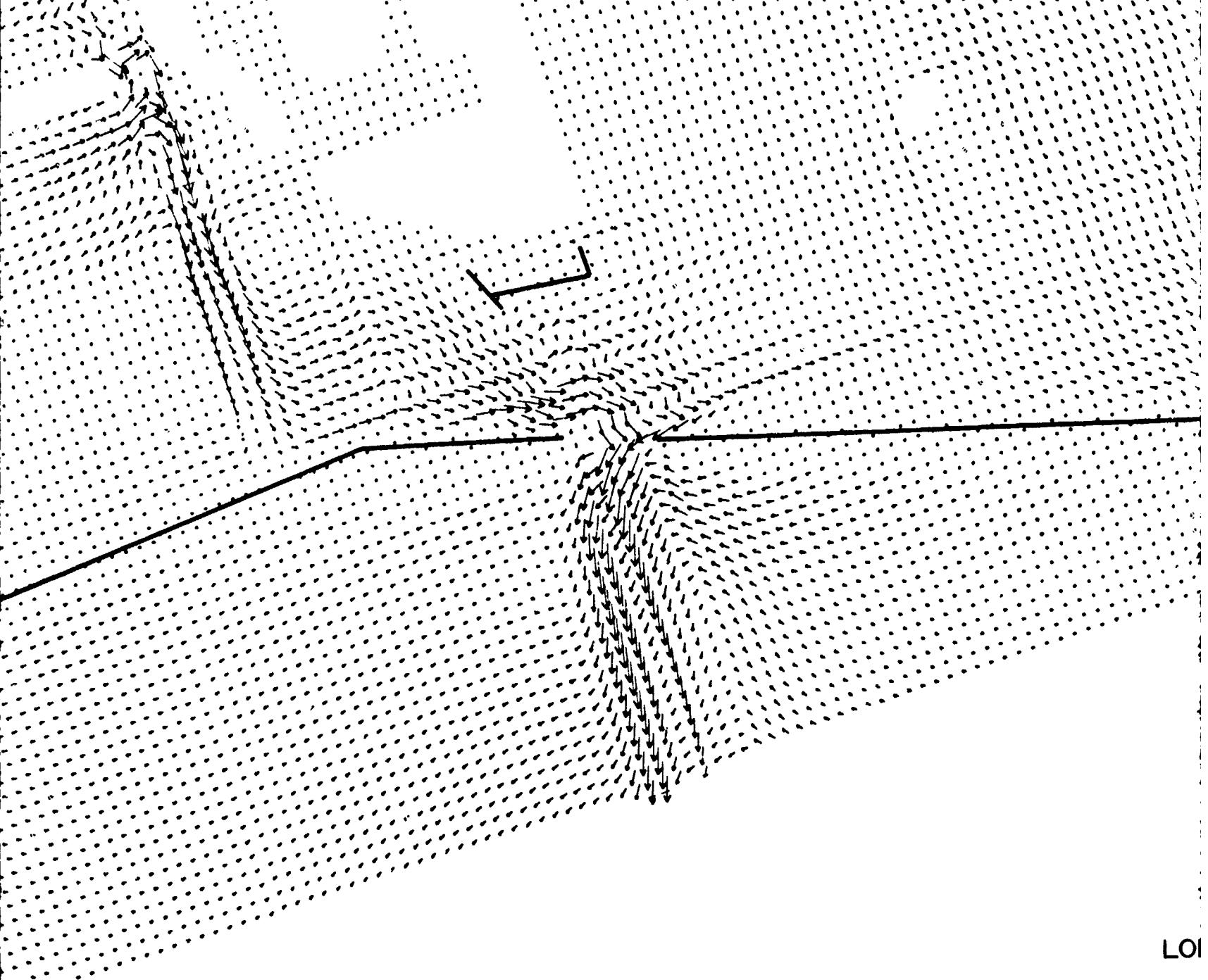
VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERN





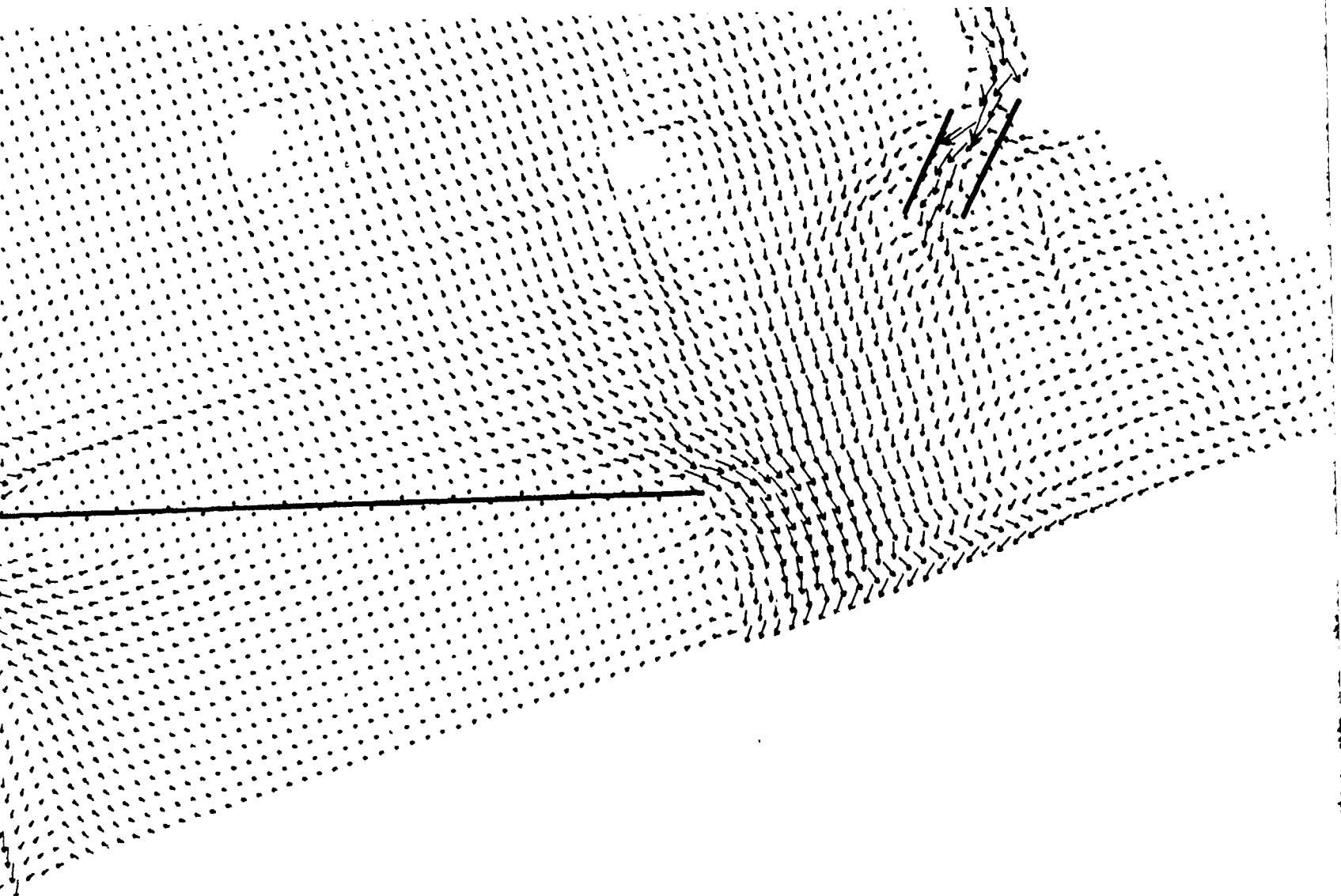
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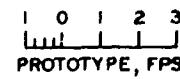
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SCALE IN FEET

2000 0 2000 4000



VELOCITY SCALE

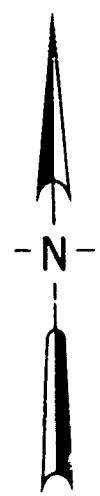


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

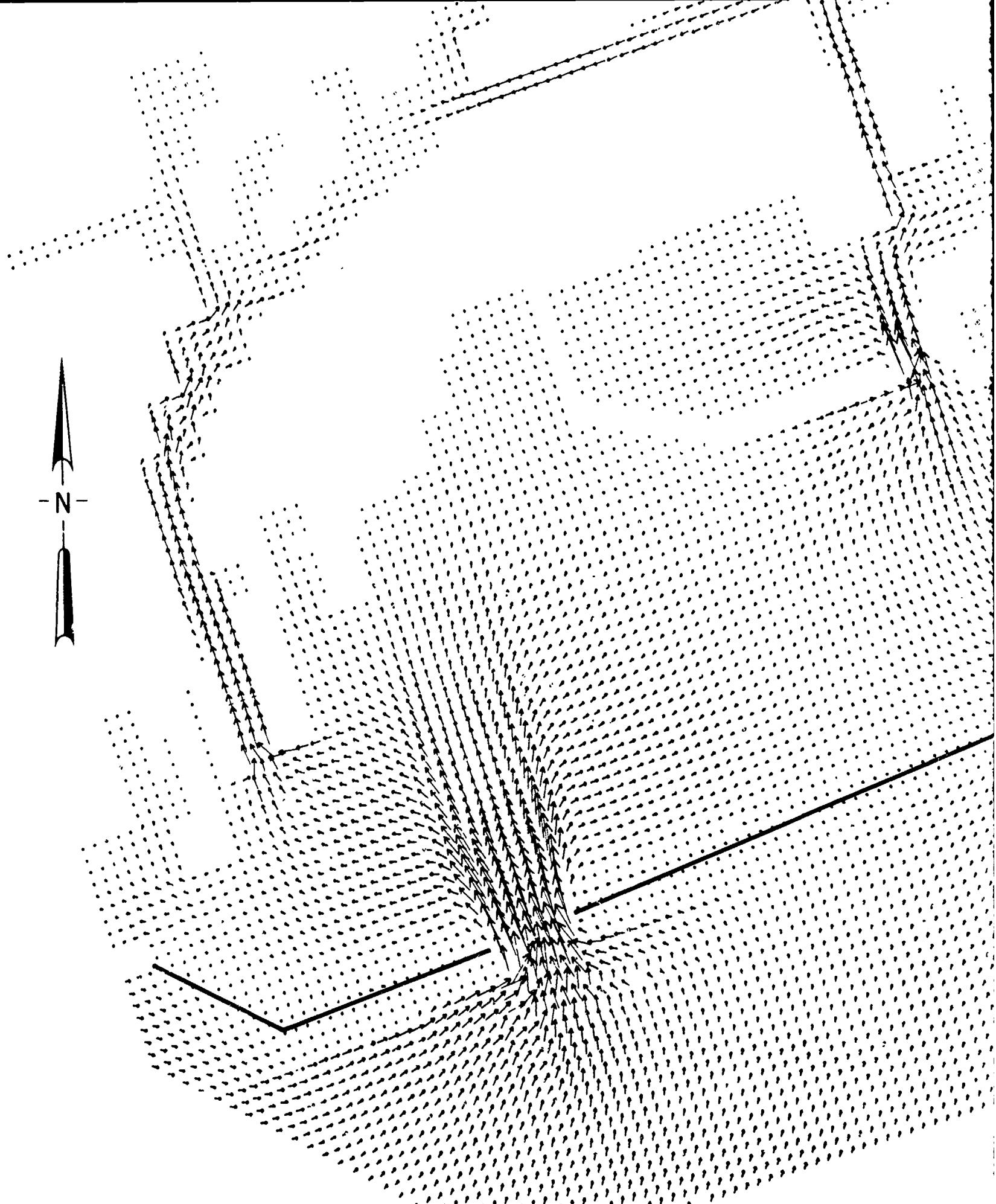
SURFACE CURRENT PATTERNS

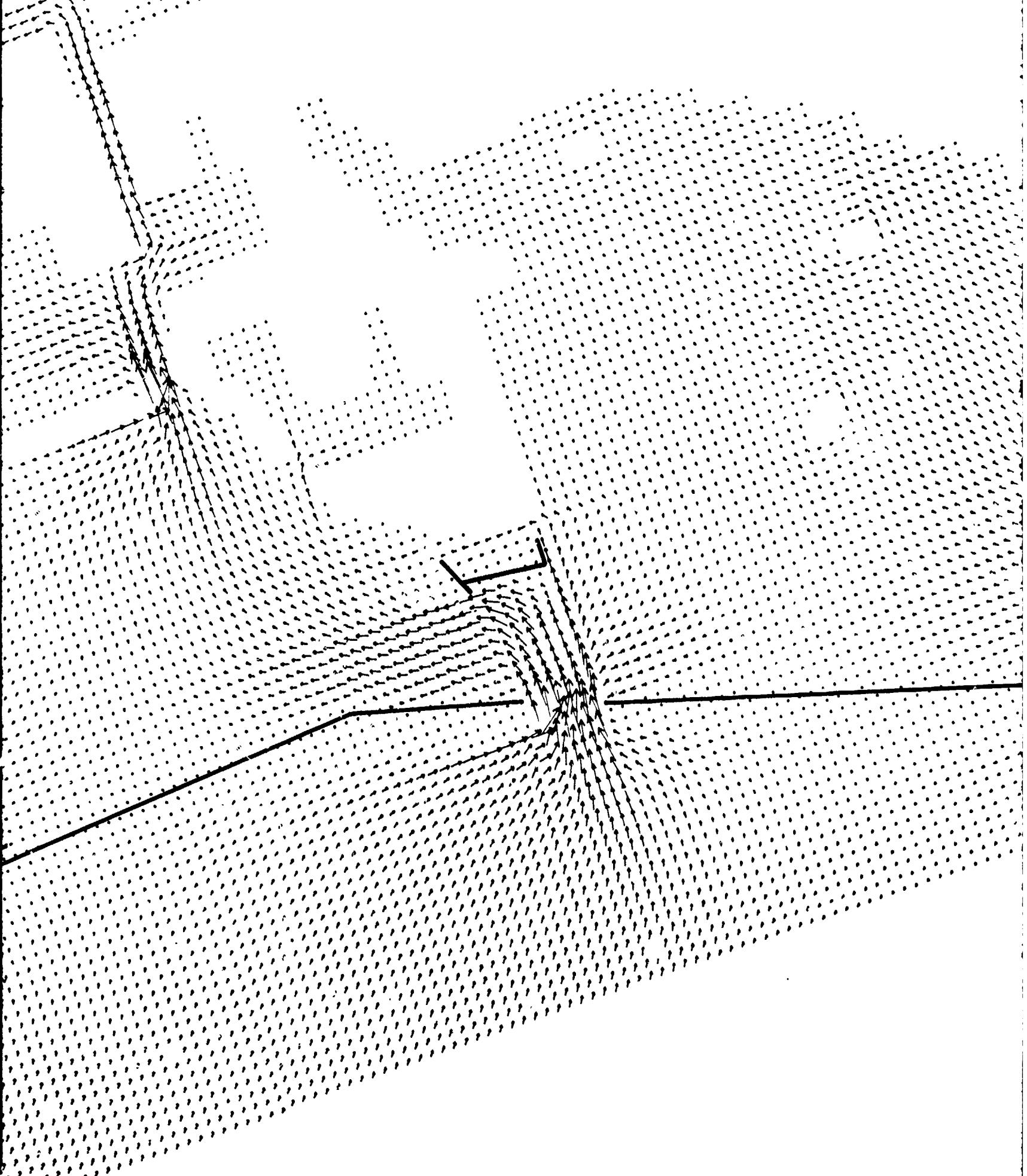
SCHEME STFP 2, 600-FT OPENING
- 82-FT CHANNEL

SPRING TIDE
HOUR 15

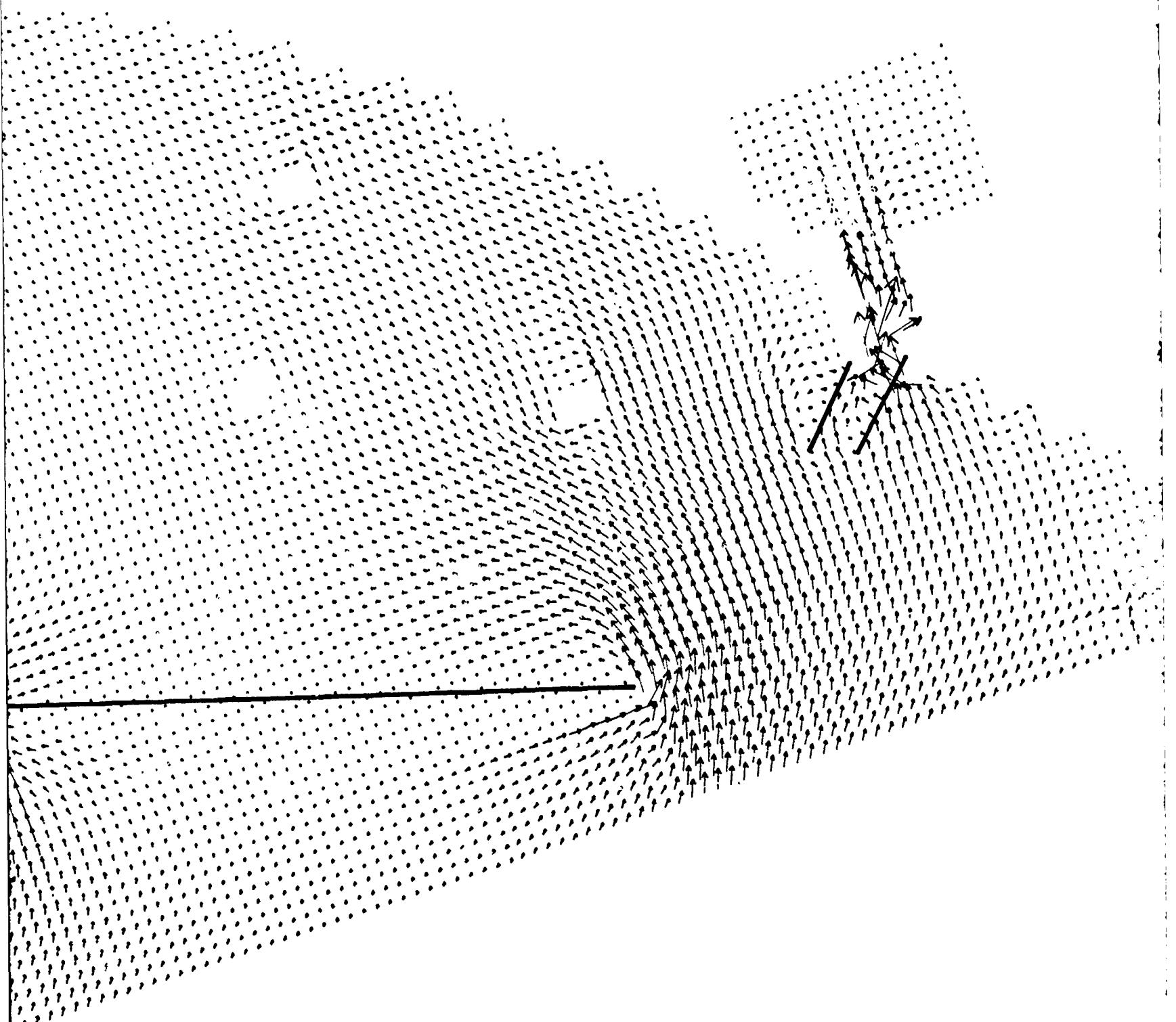


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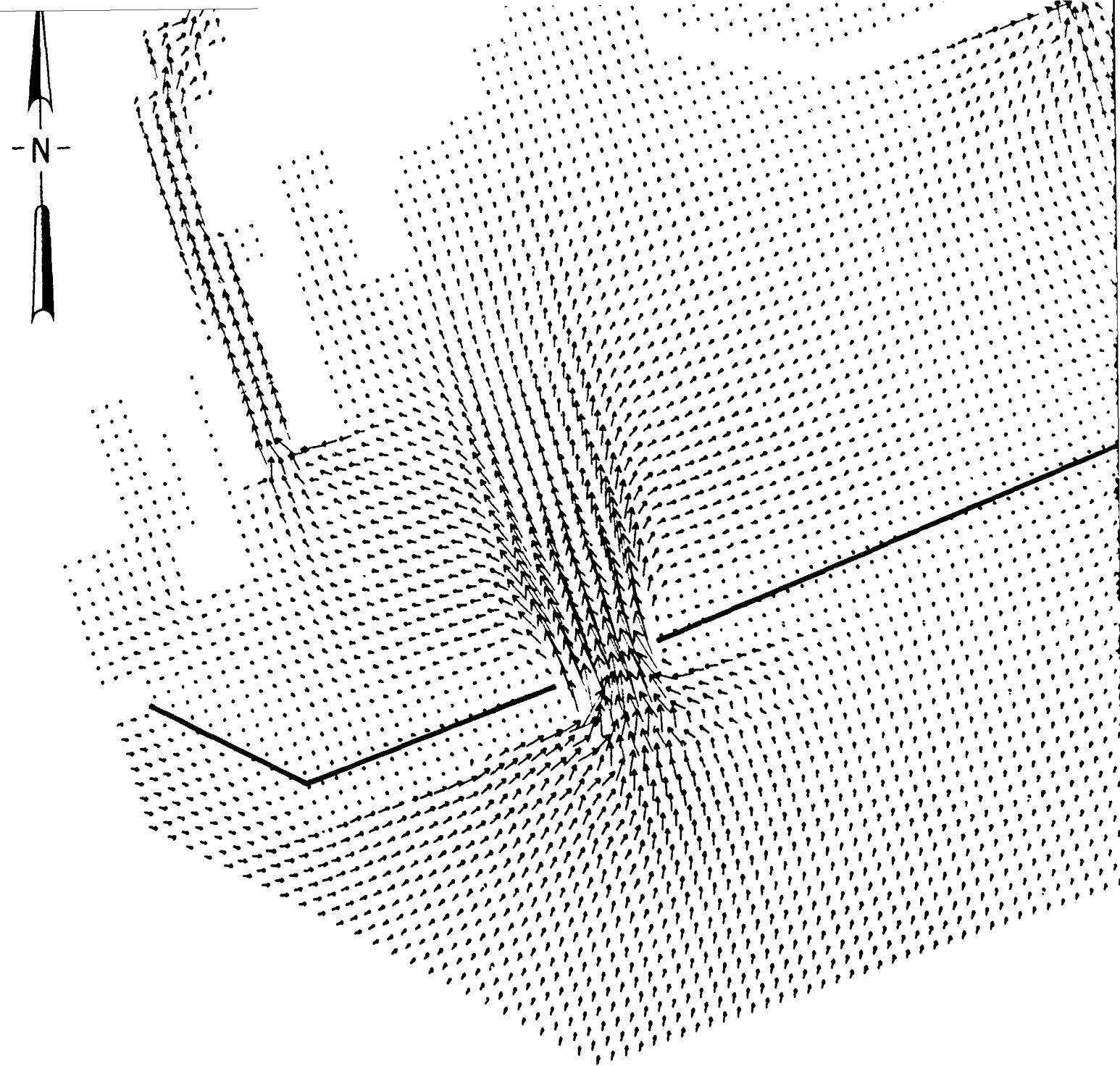
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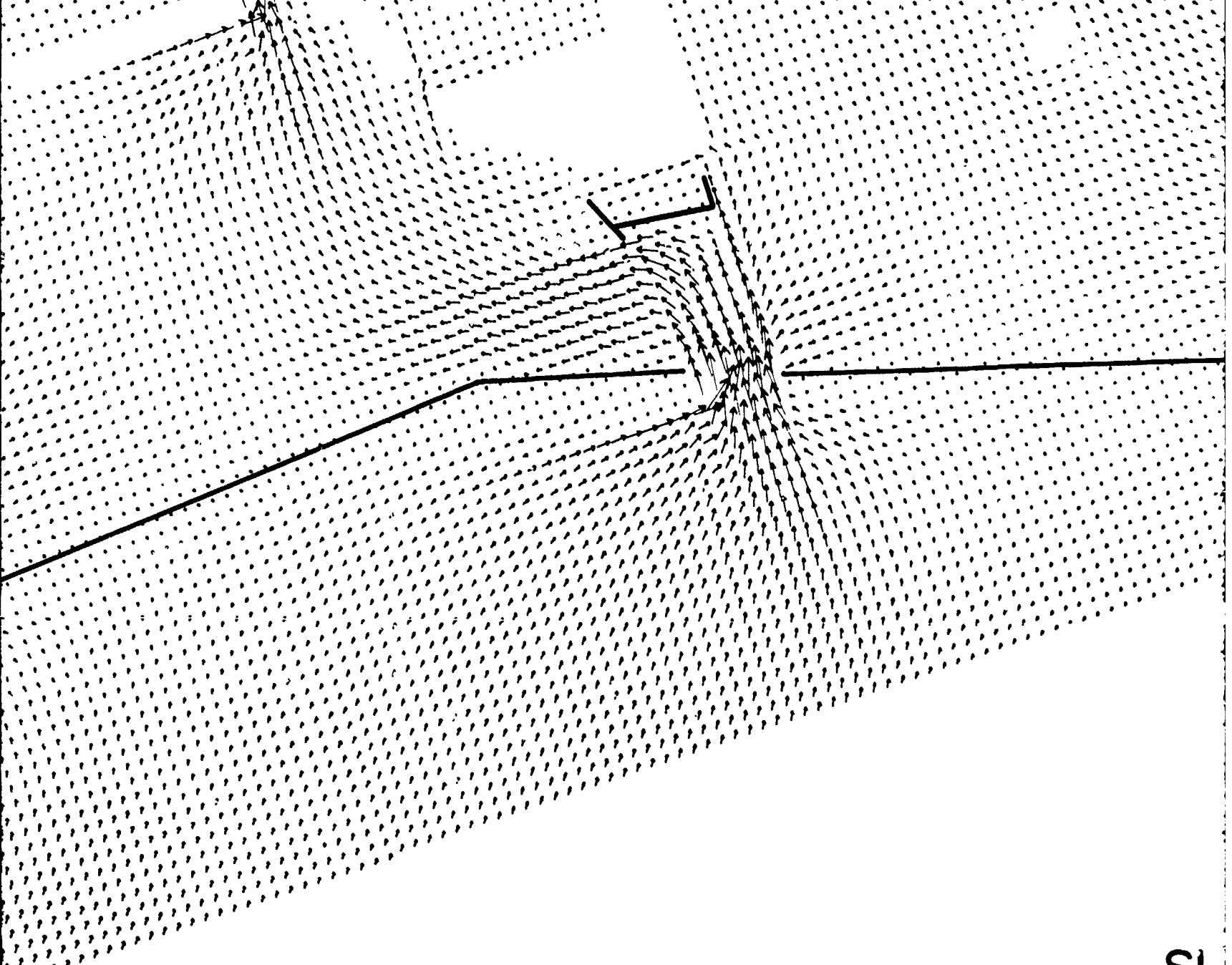
VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS



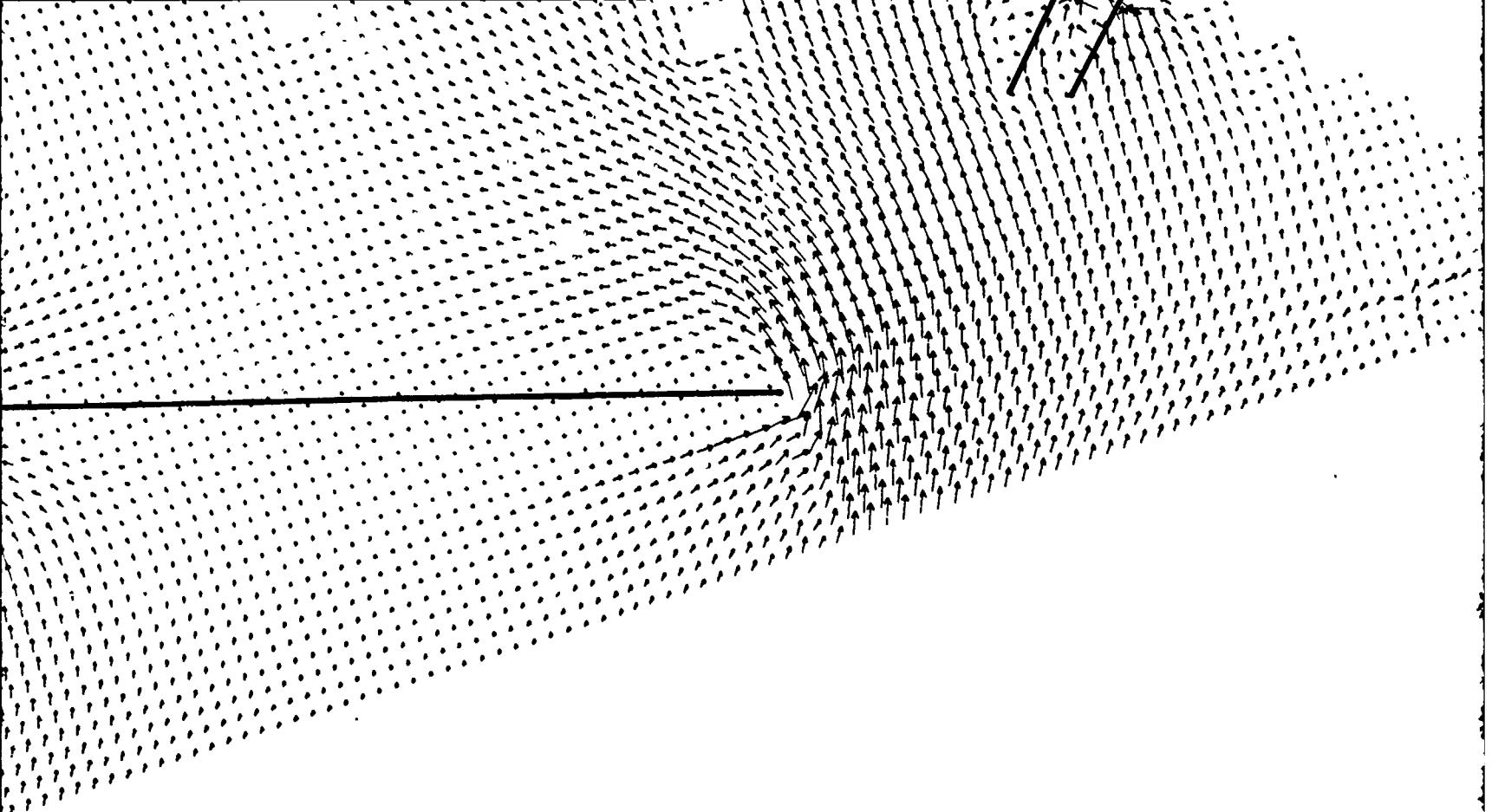
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SCALE IN FEET

2000 0 2000 4000



VELOCITY SCALE

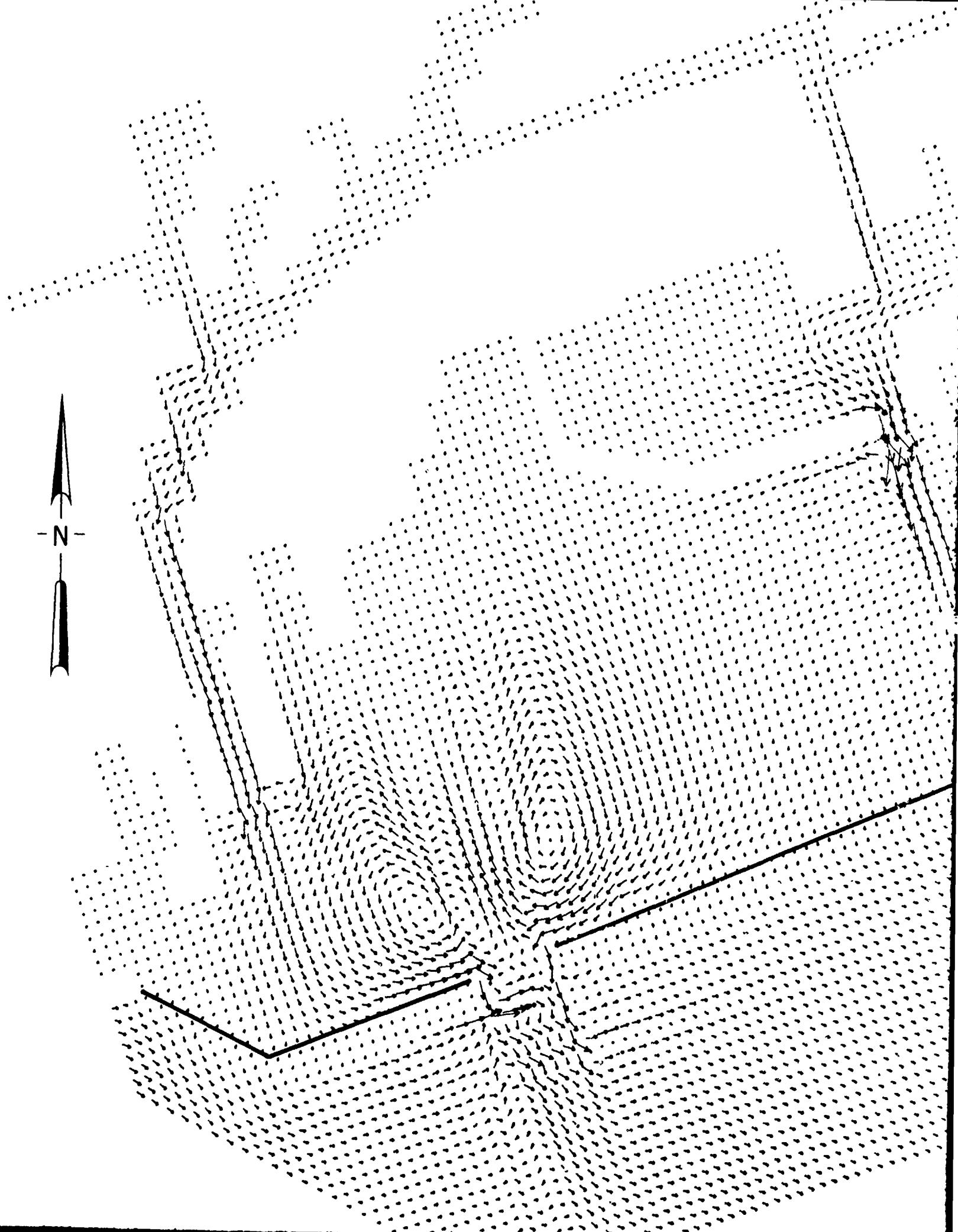
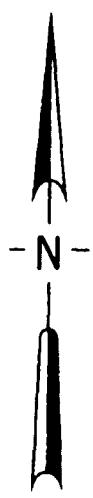


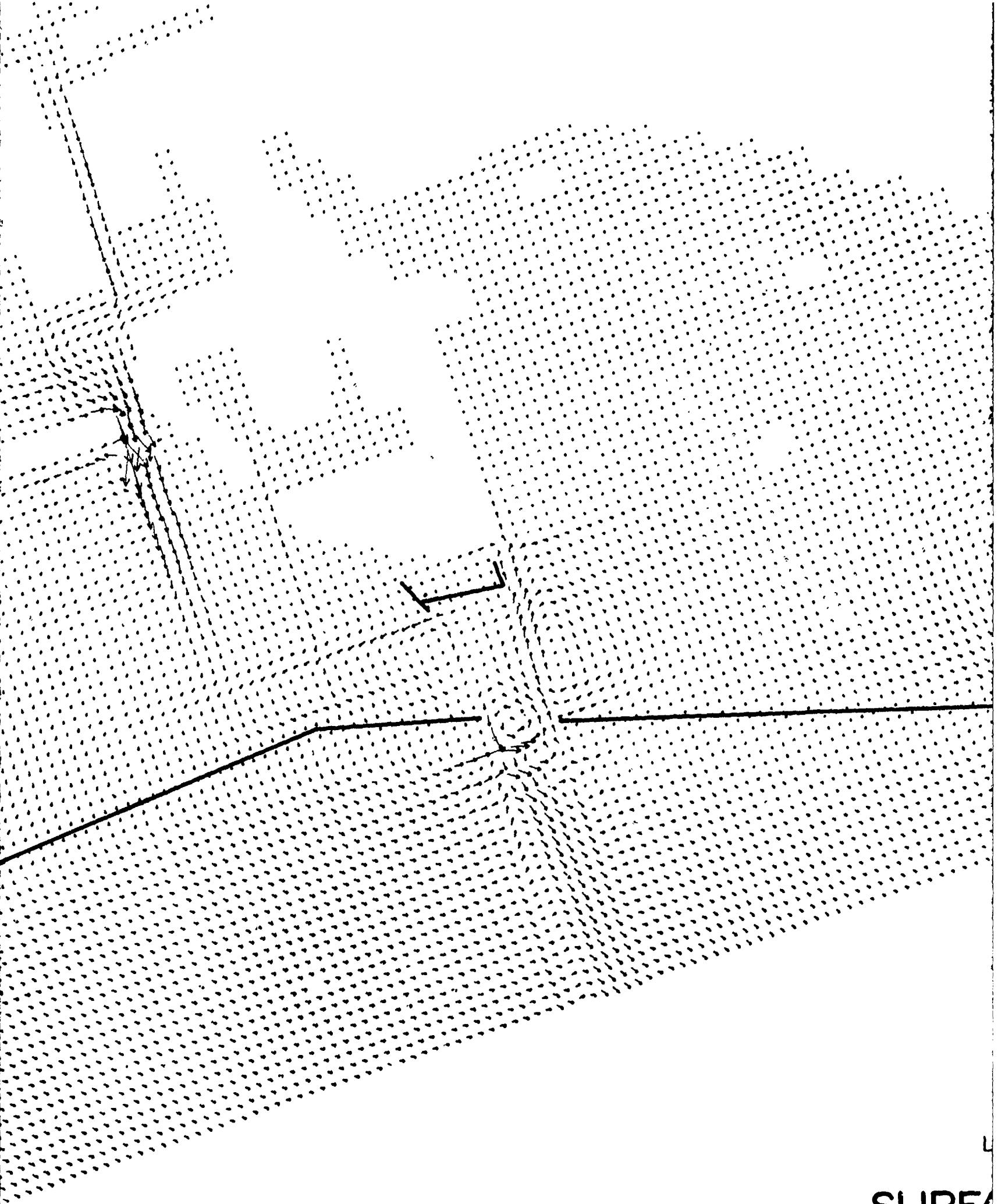
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

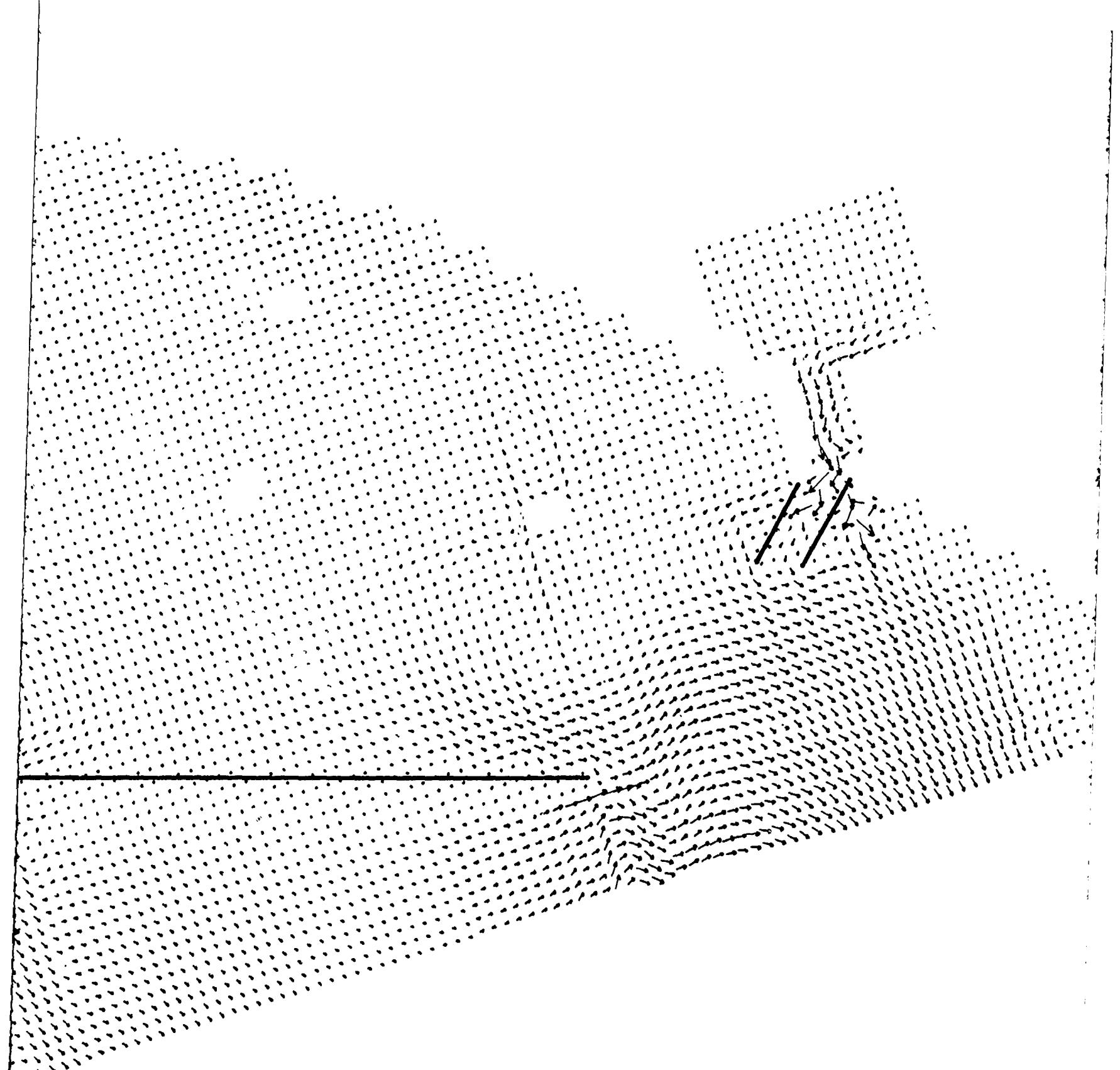
SCHEME STFP 2, 600-FT OPENING
- 82-FT CHANNEL

SPRING TIDE
HOUR 19

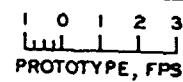




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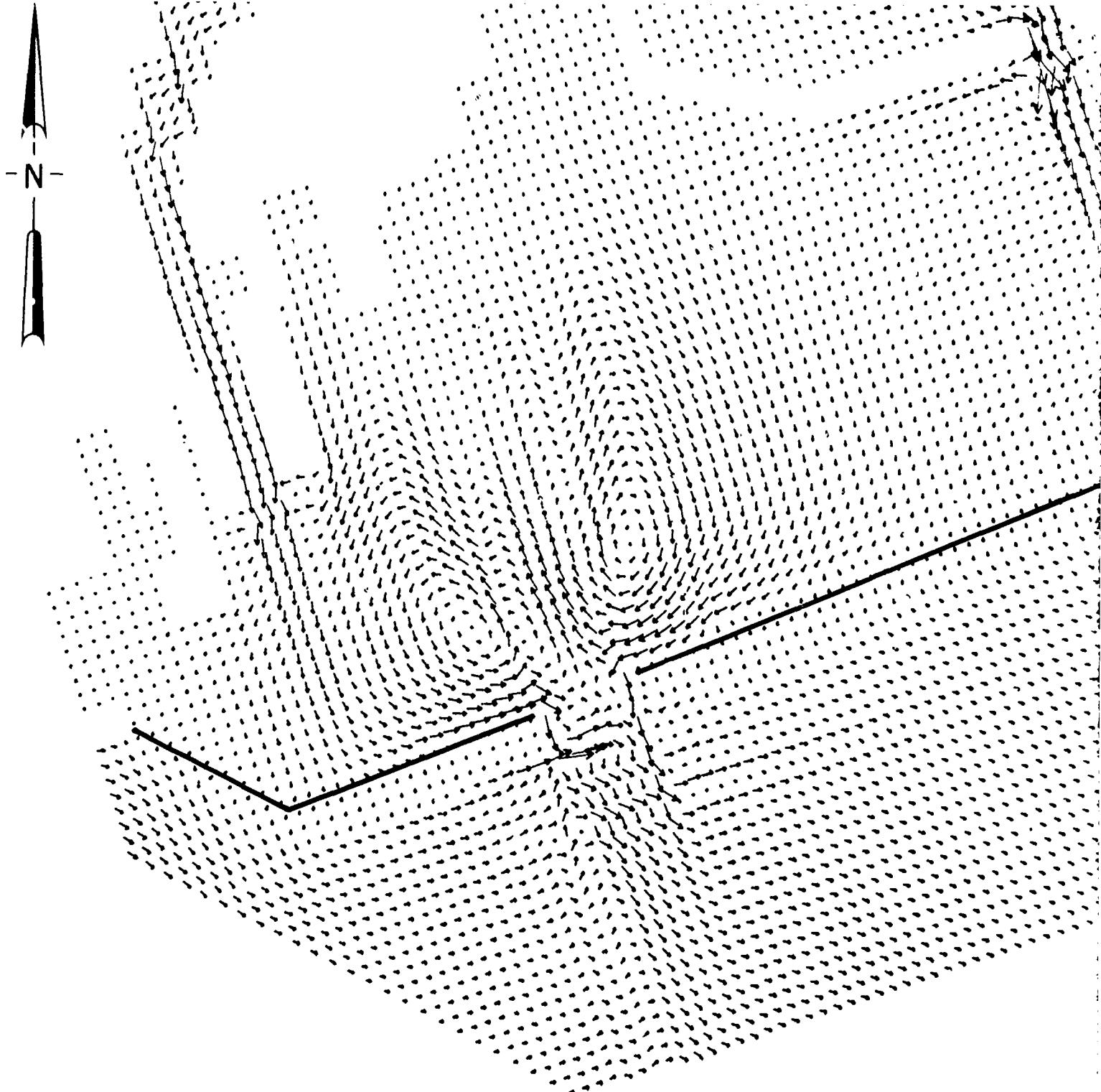


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS



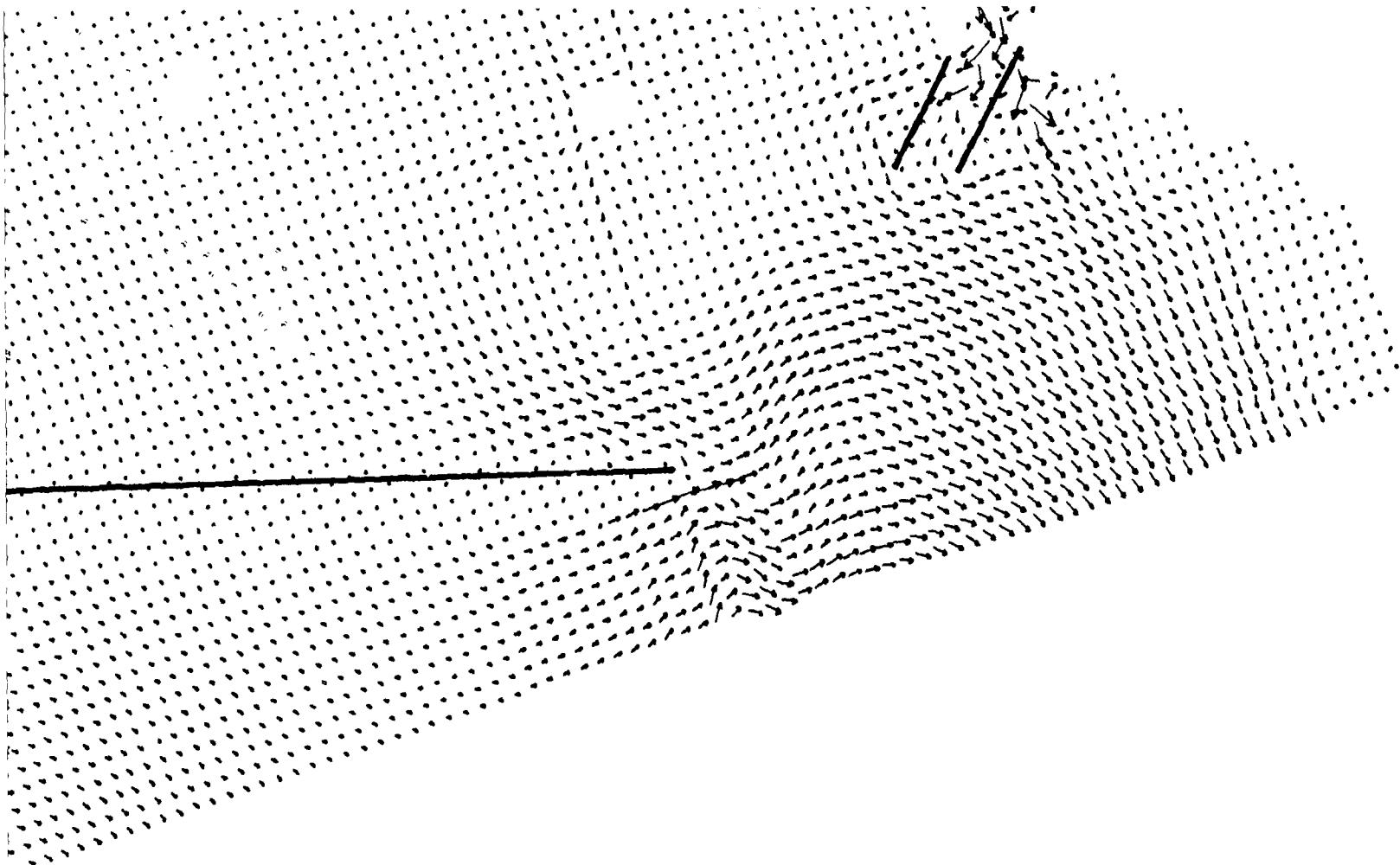
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SCALE IN FEET

2000 0 2000 4000

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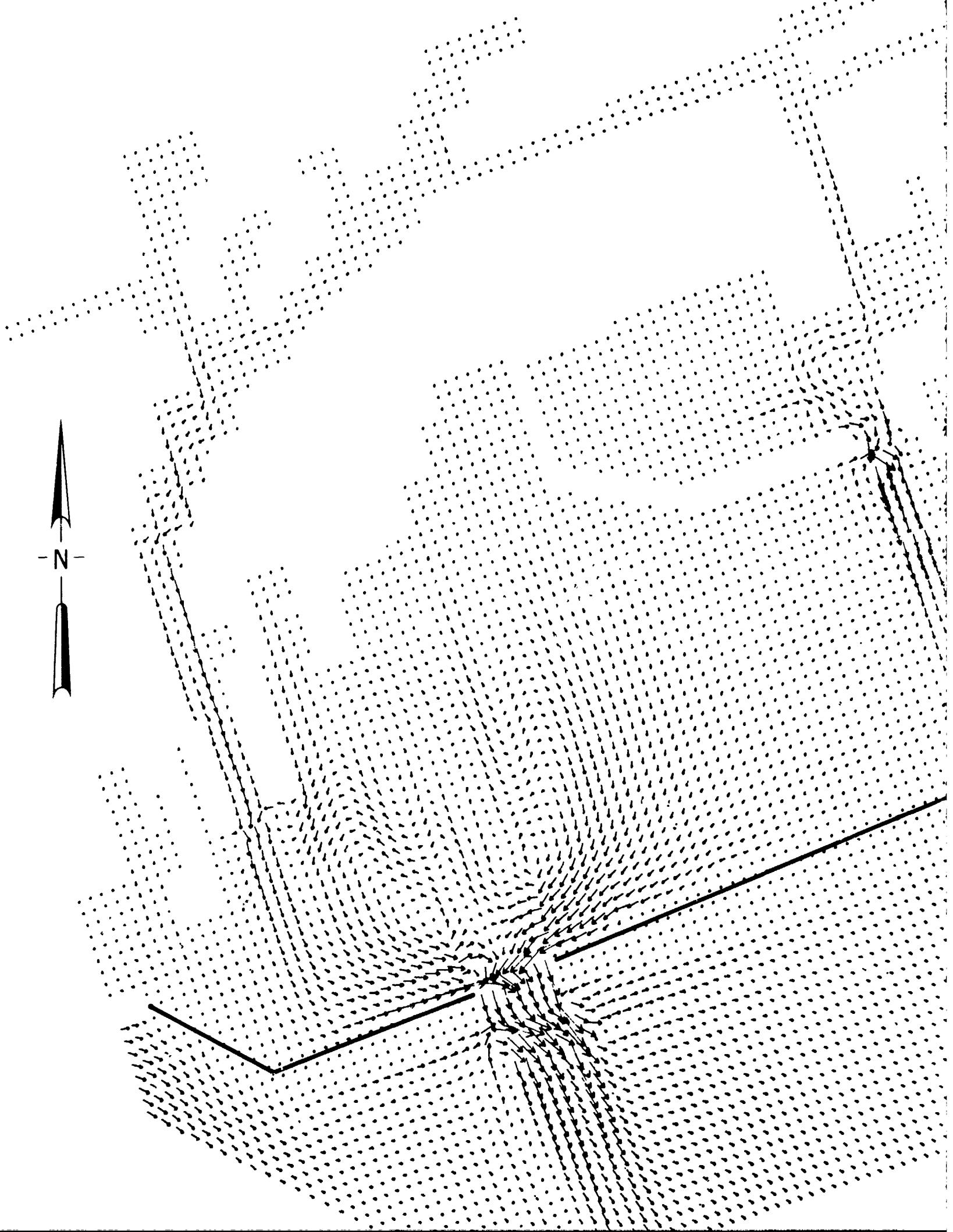
VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

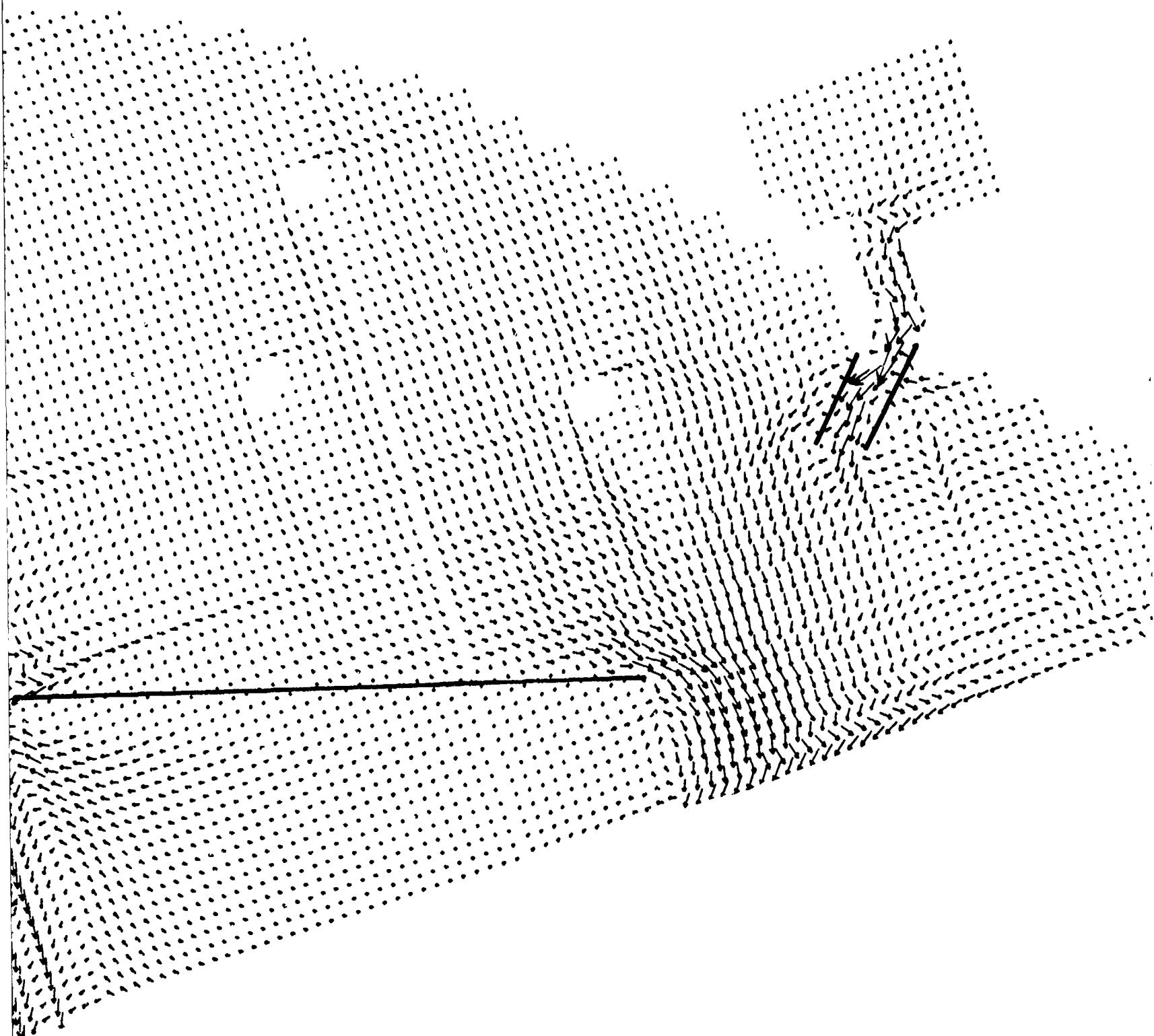
SCHEME STFP 2, 600-FT OPENING
-82-FT CHANNEL

SPRING TIDE
HOUR 22





SURF



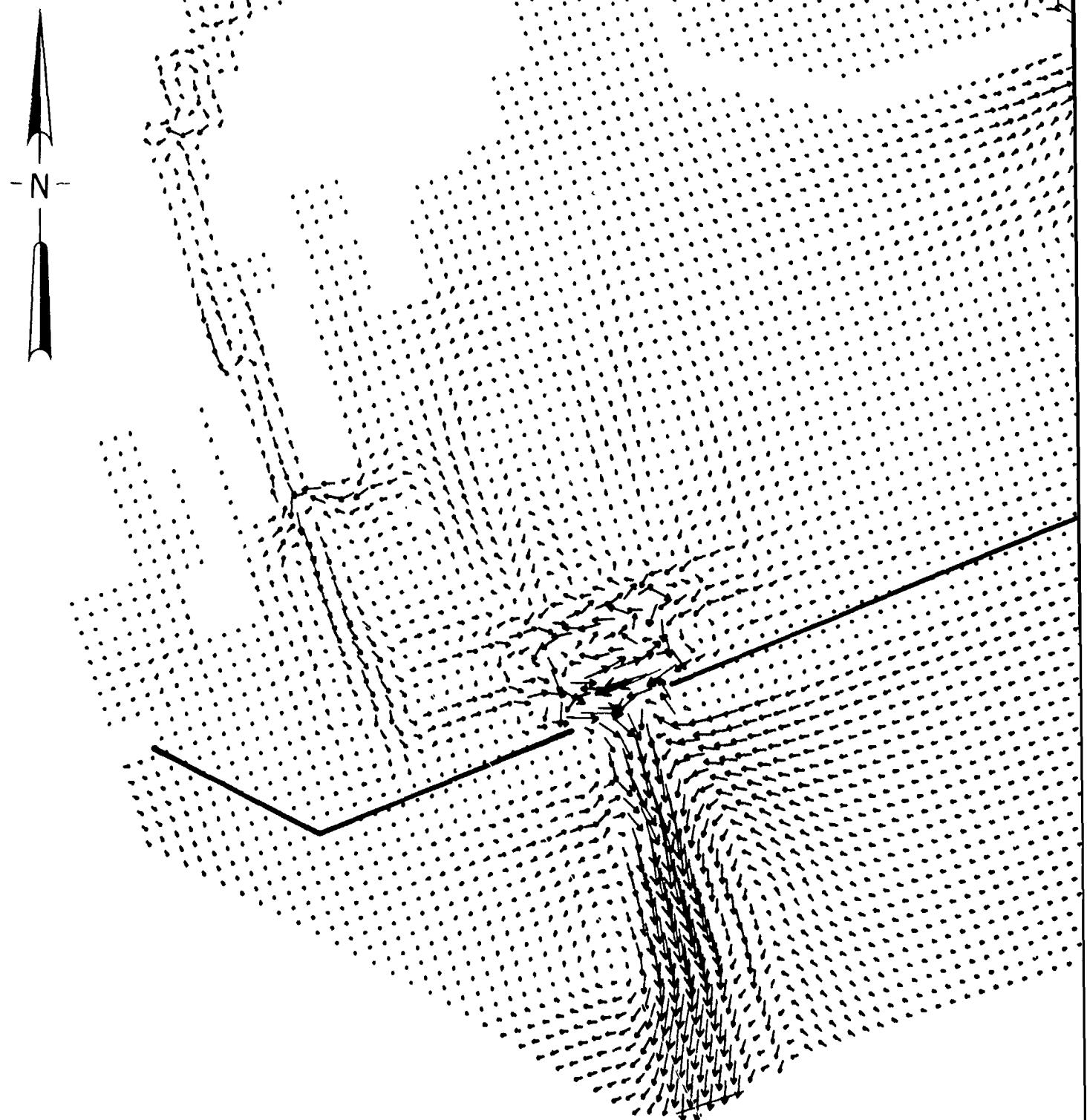
VELOCITY SCALE

1 0 1 2 3

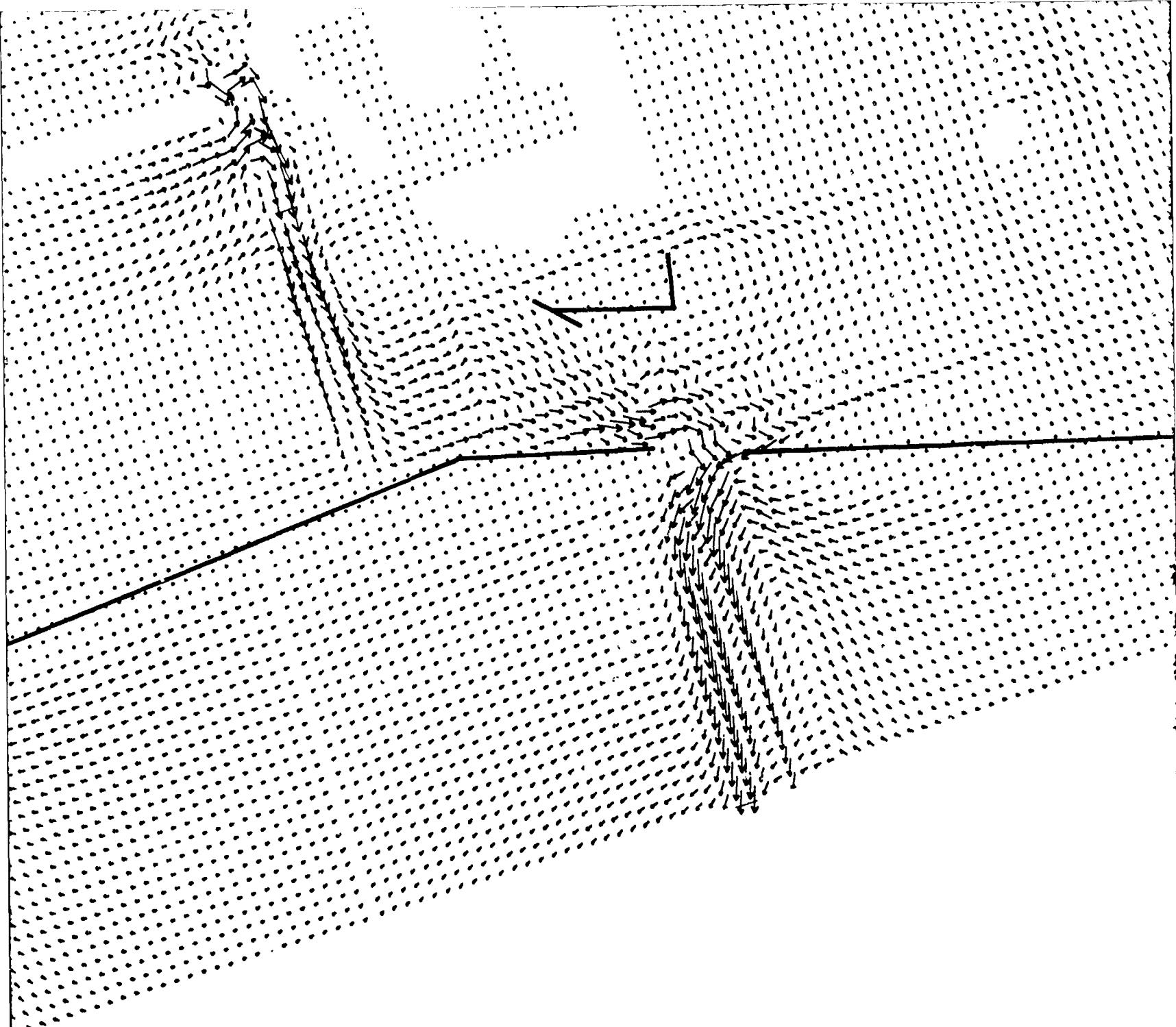
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PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SHORELINE CURRENT PATTERN



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- 1 -



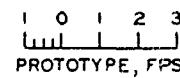
SCALE IN FEET

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VELOCITY SCALE

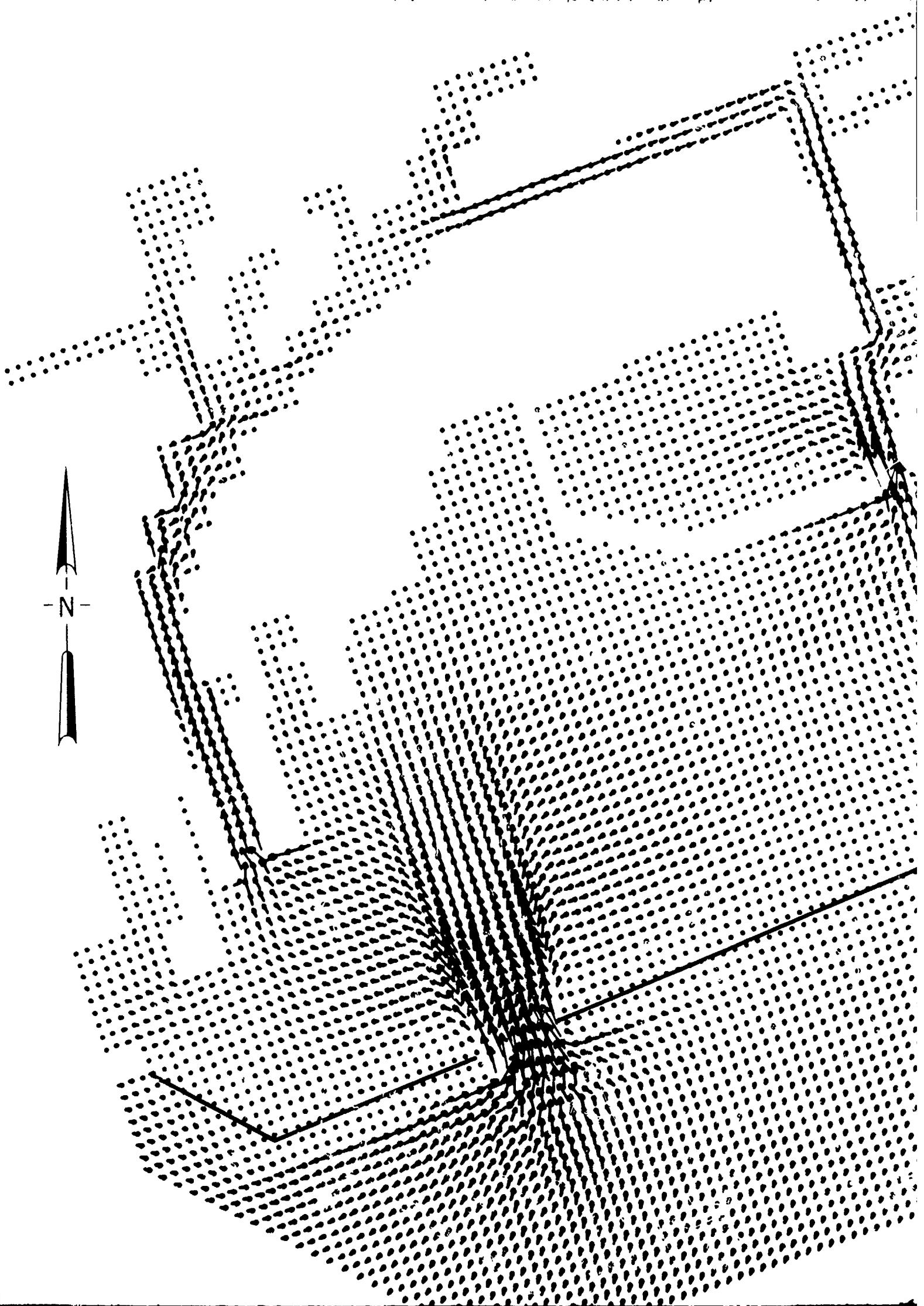


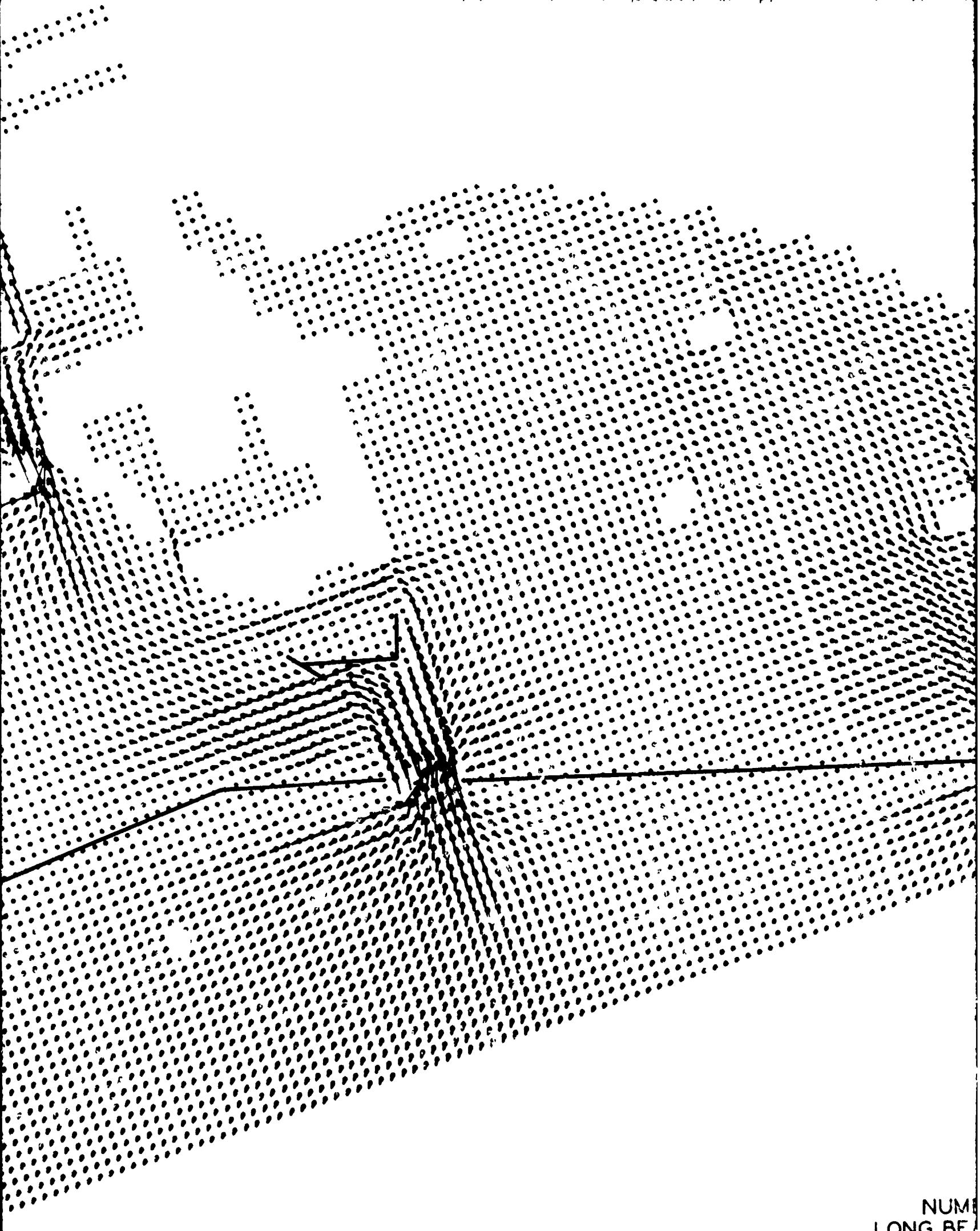
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

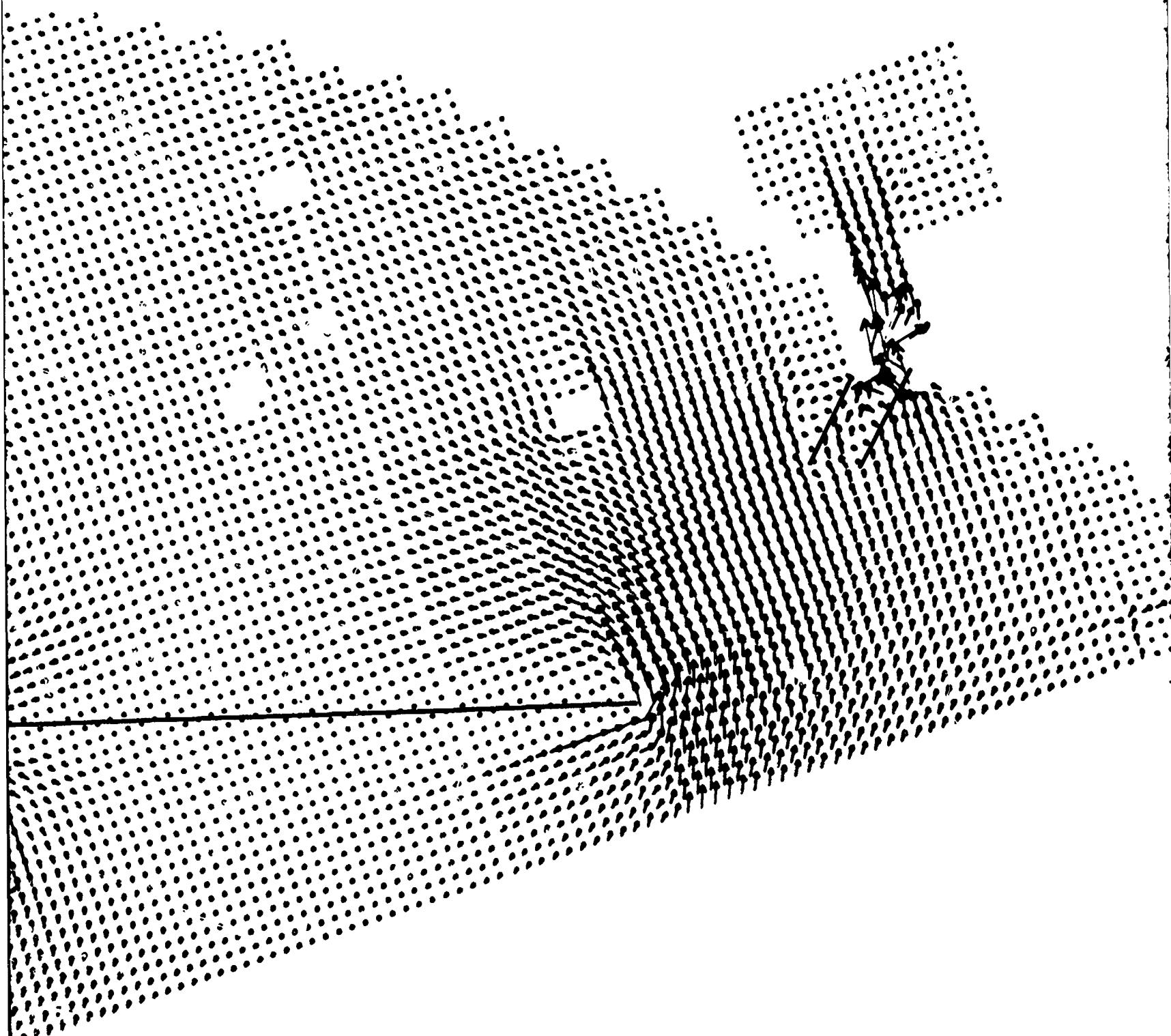
SCHEME STFP 3, -82-FT CHANNEL

SPRING TIDE
HOUR 15





NUM
LONG BE

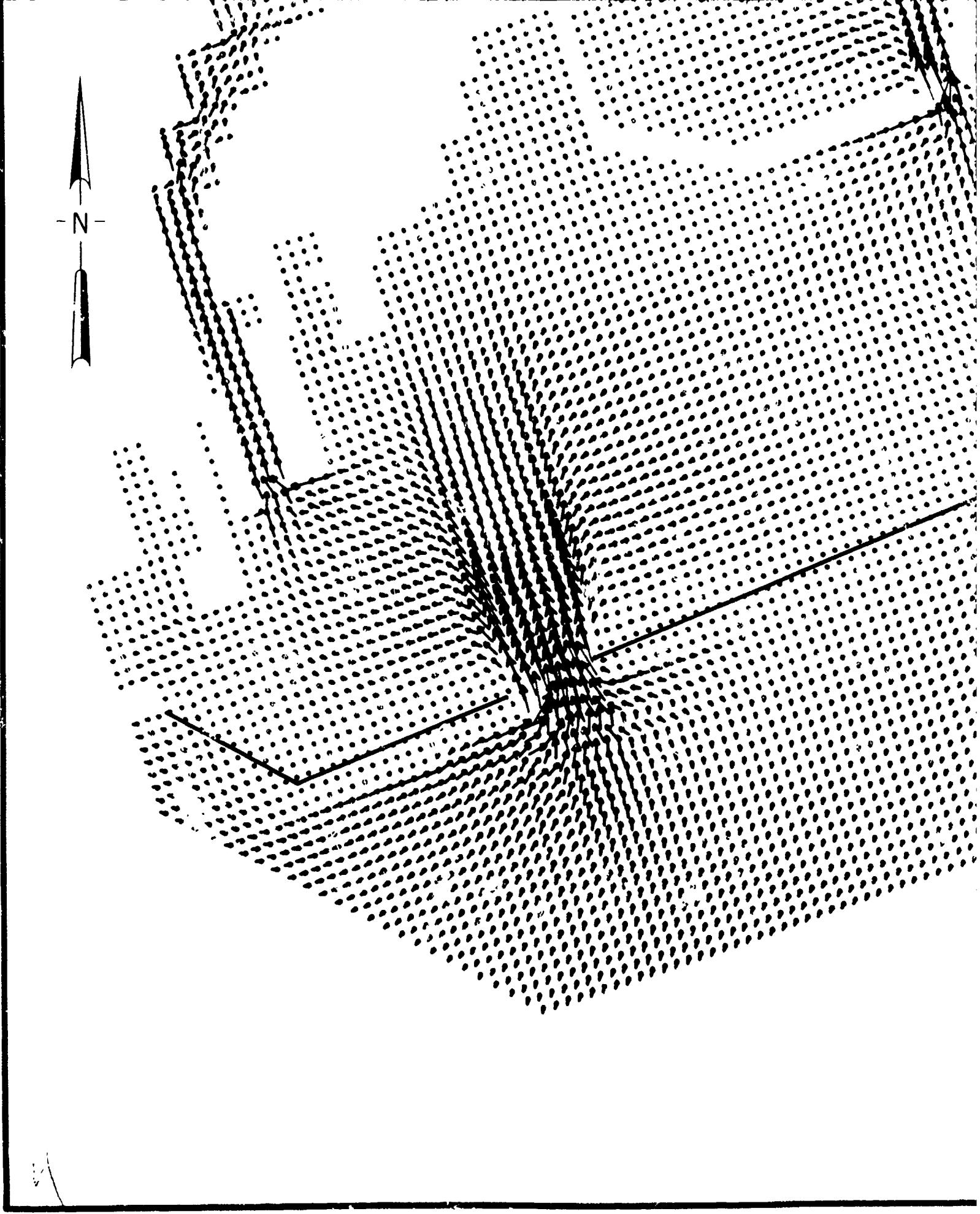


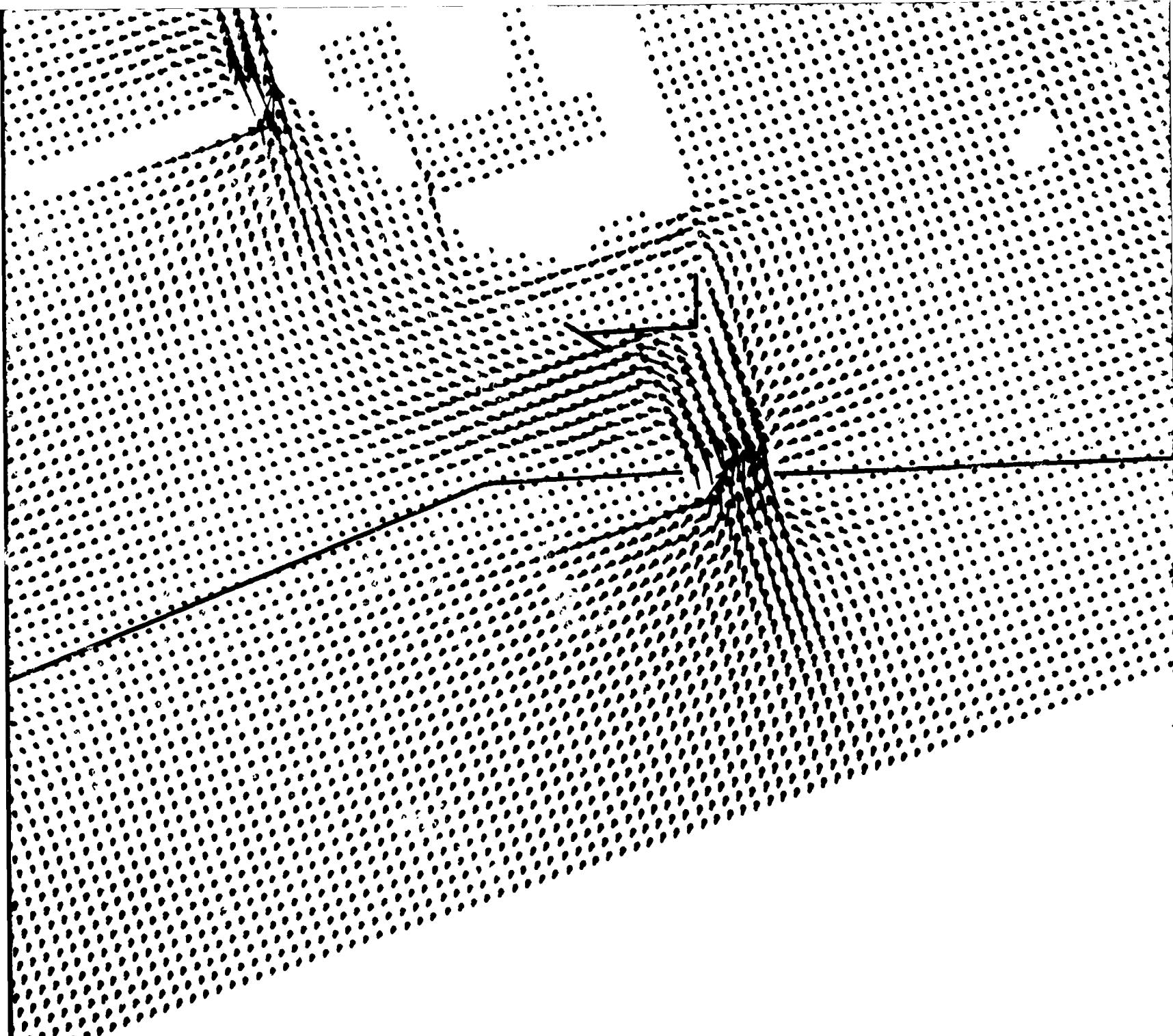
VELOCITY SCALE

1	0	1	2	3

PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

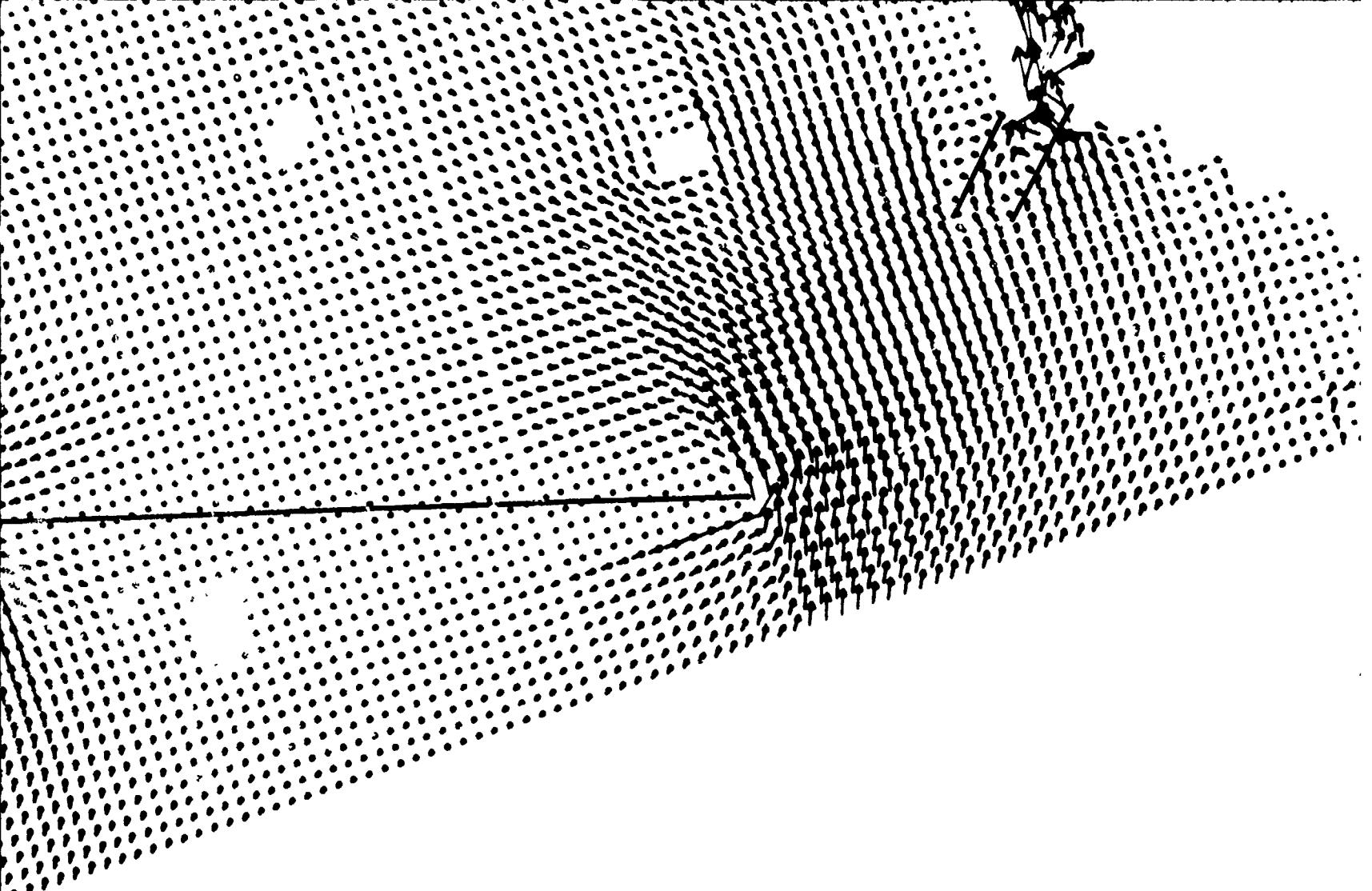




SCALE IN FEET

2000 0 2000 4000

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VELOCITY SCALE

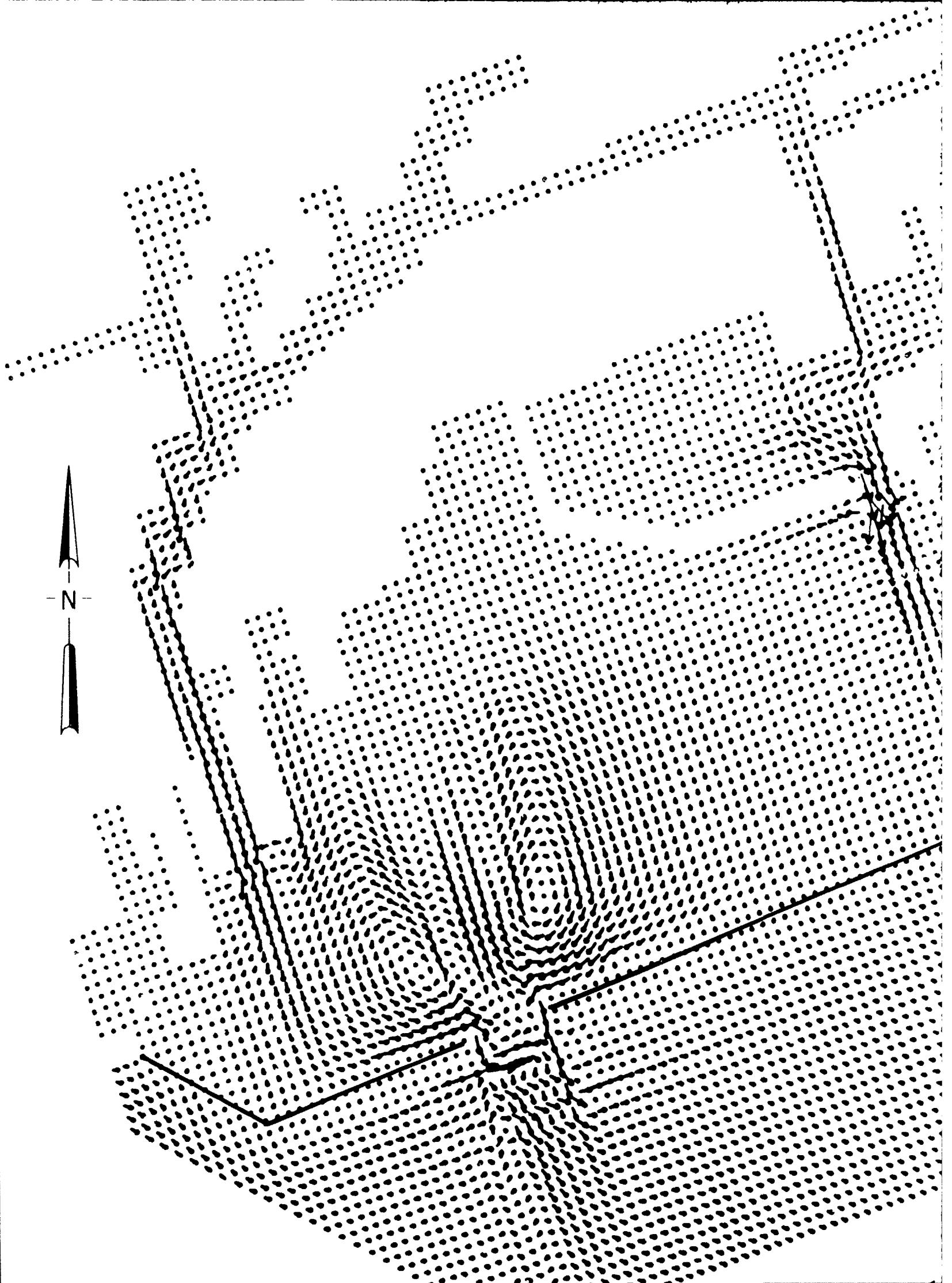
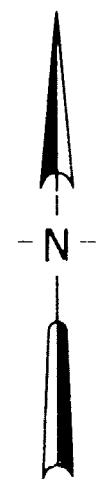
1 0 1 2 3
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PROTOTYPE, FPS

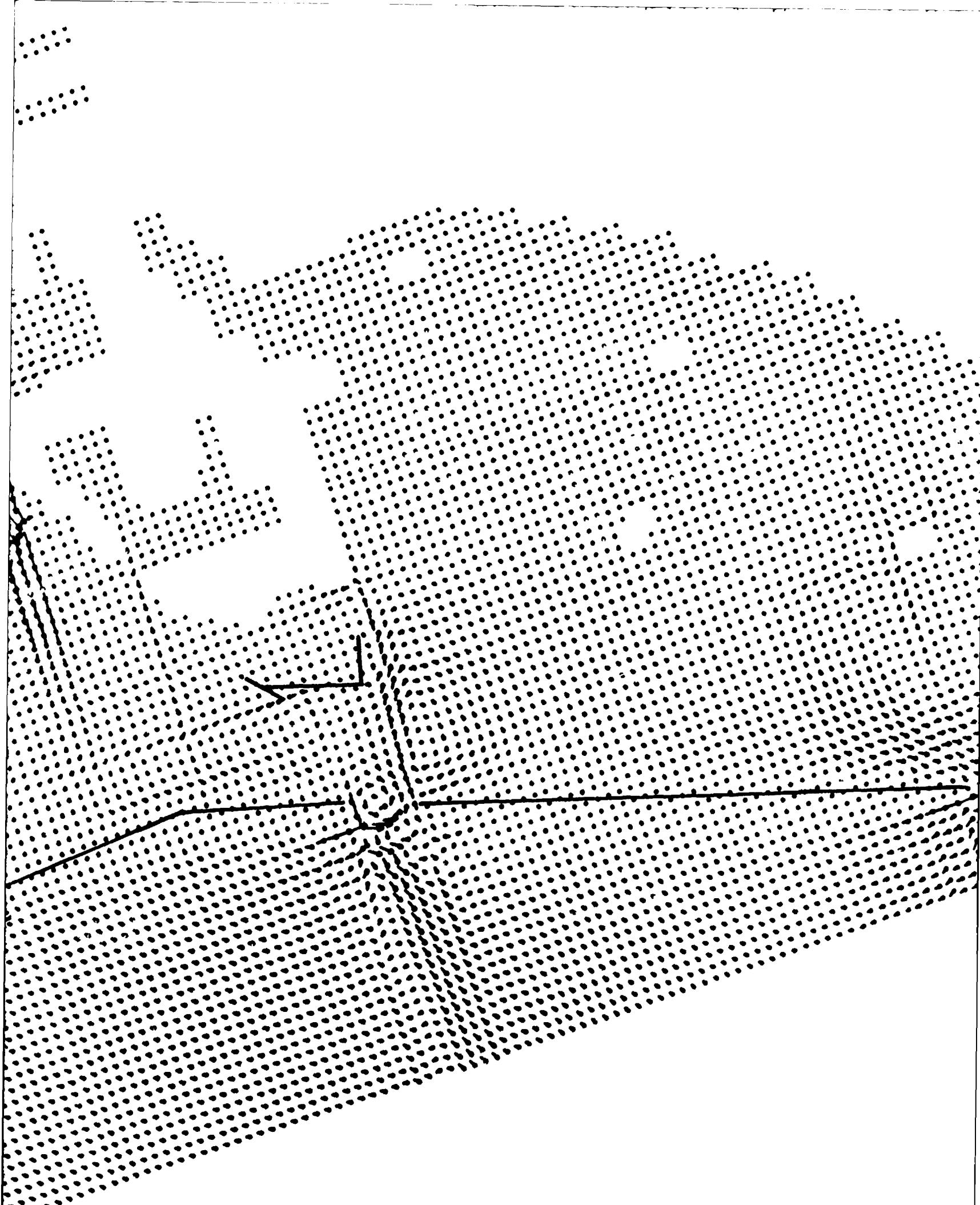
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

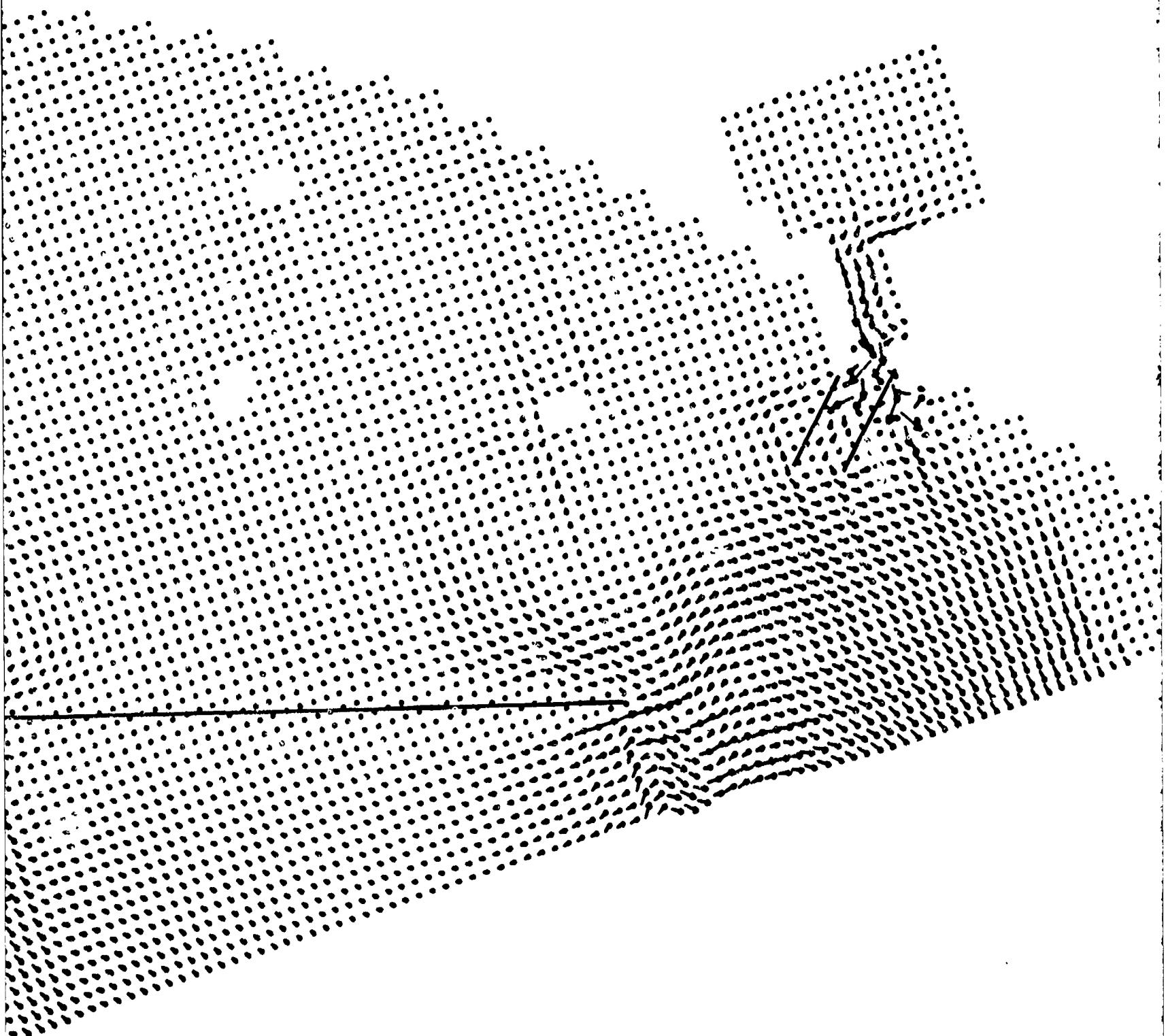
SCHEME STFP 3, -82-FT CHANNEL

**SPRING TIDE
HOUR 19**





NUMERIC
LONG BEACH



VELOCITY SCALE

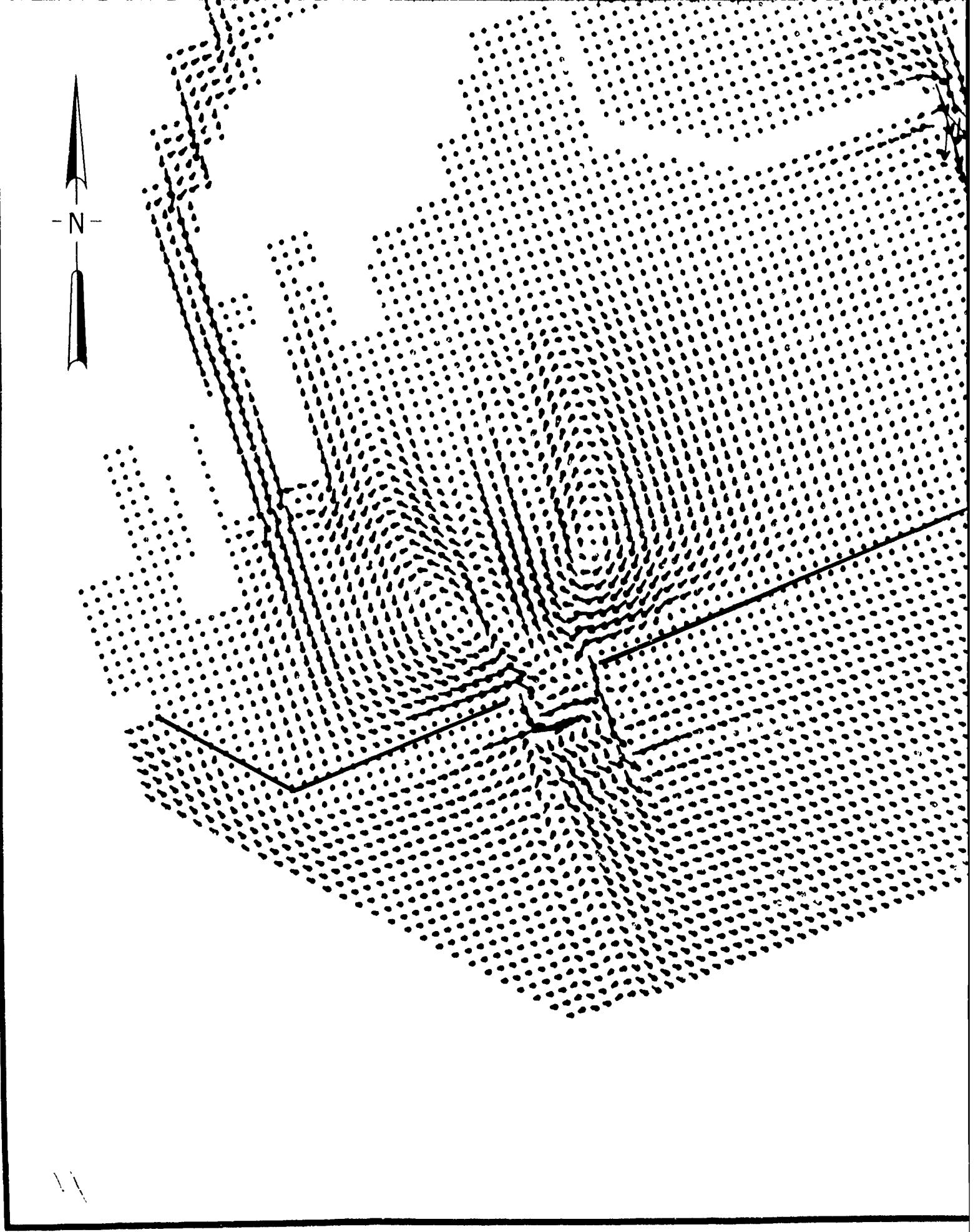
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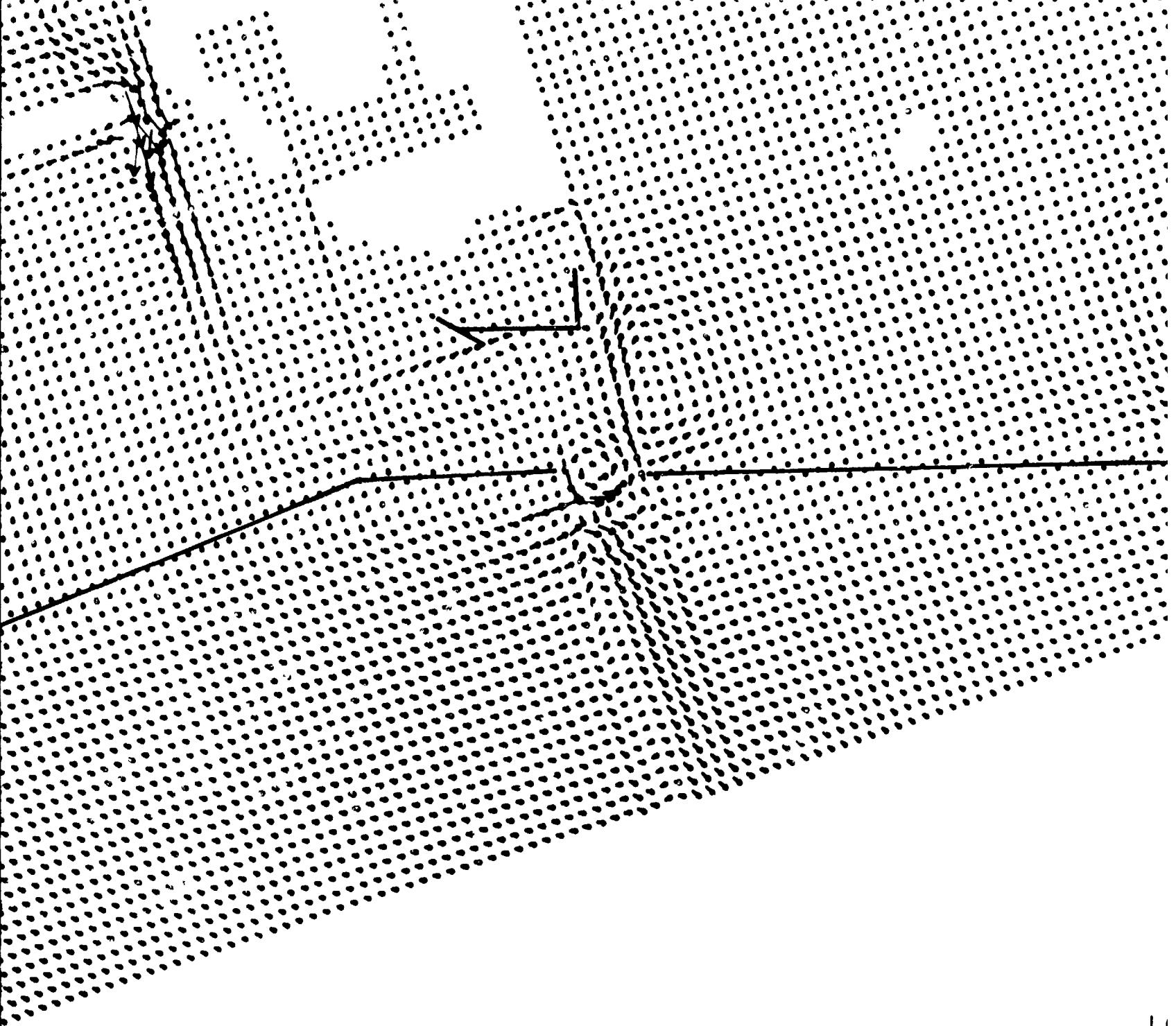
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS



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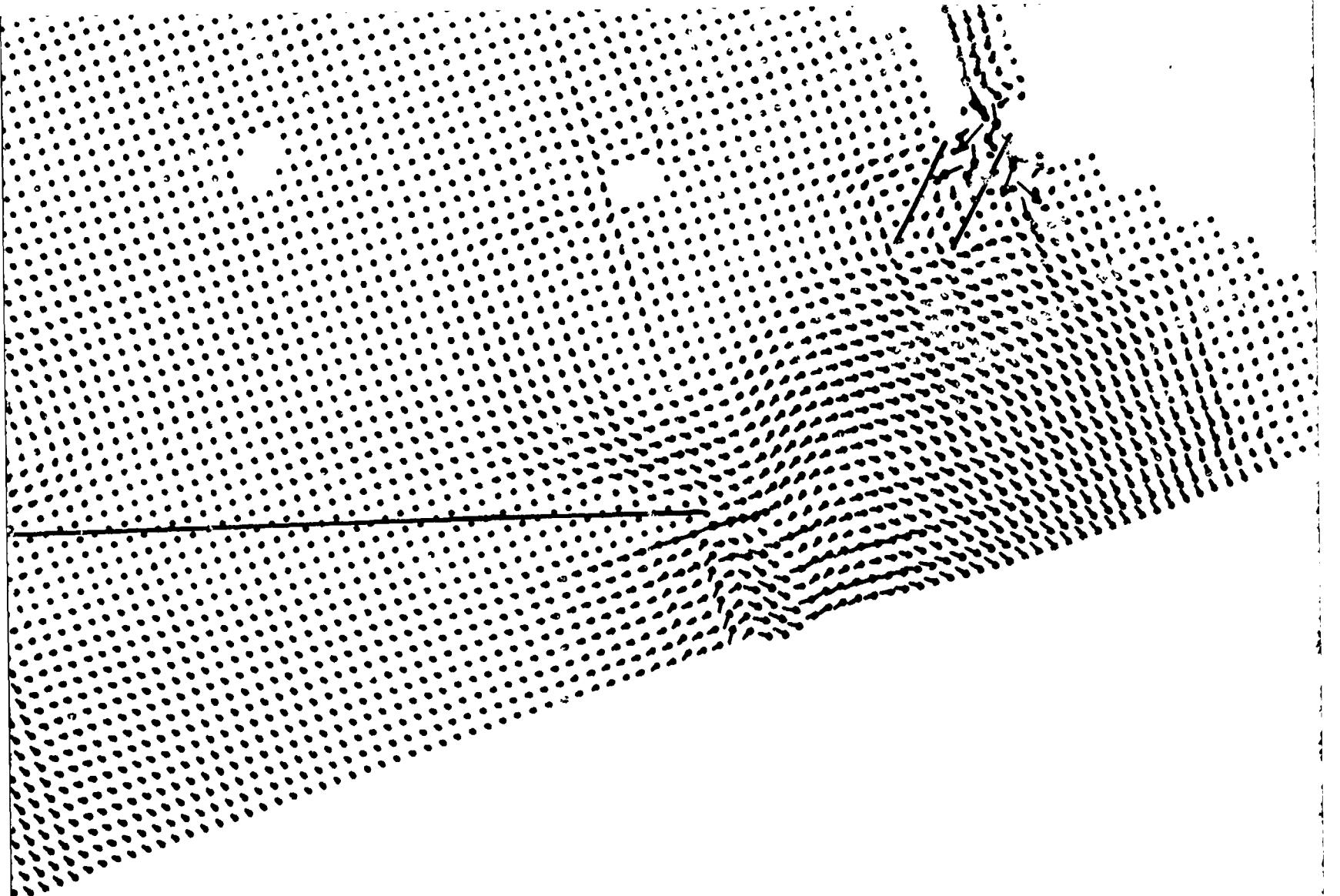


SCALE IN FEET

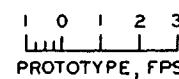
2000 0 2000 4000

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VELOCITY SCALE

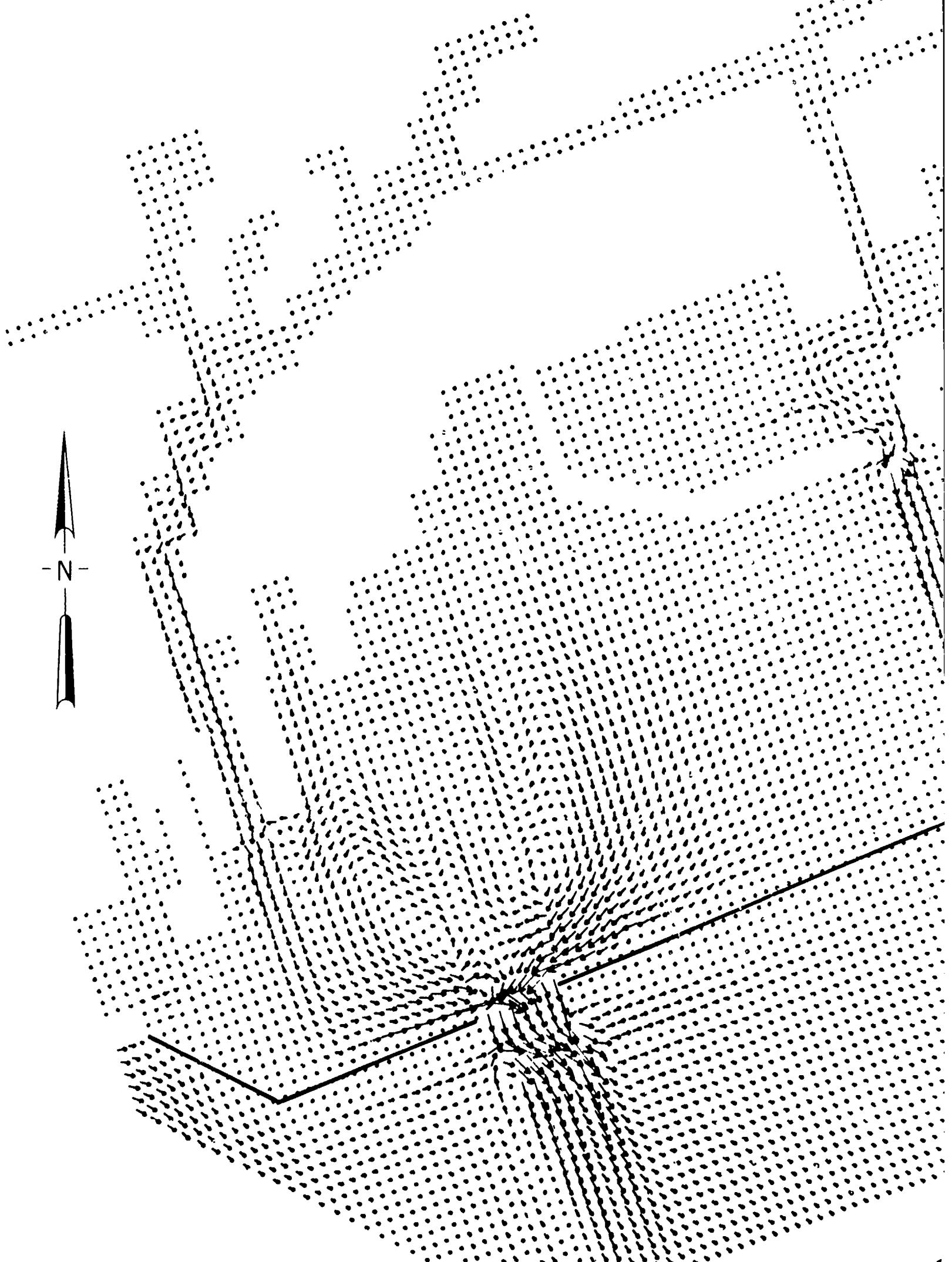


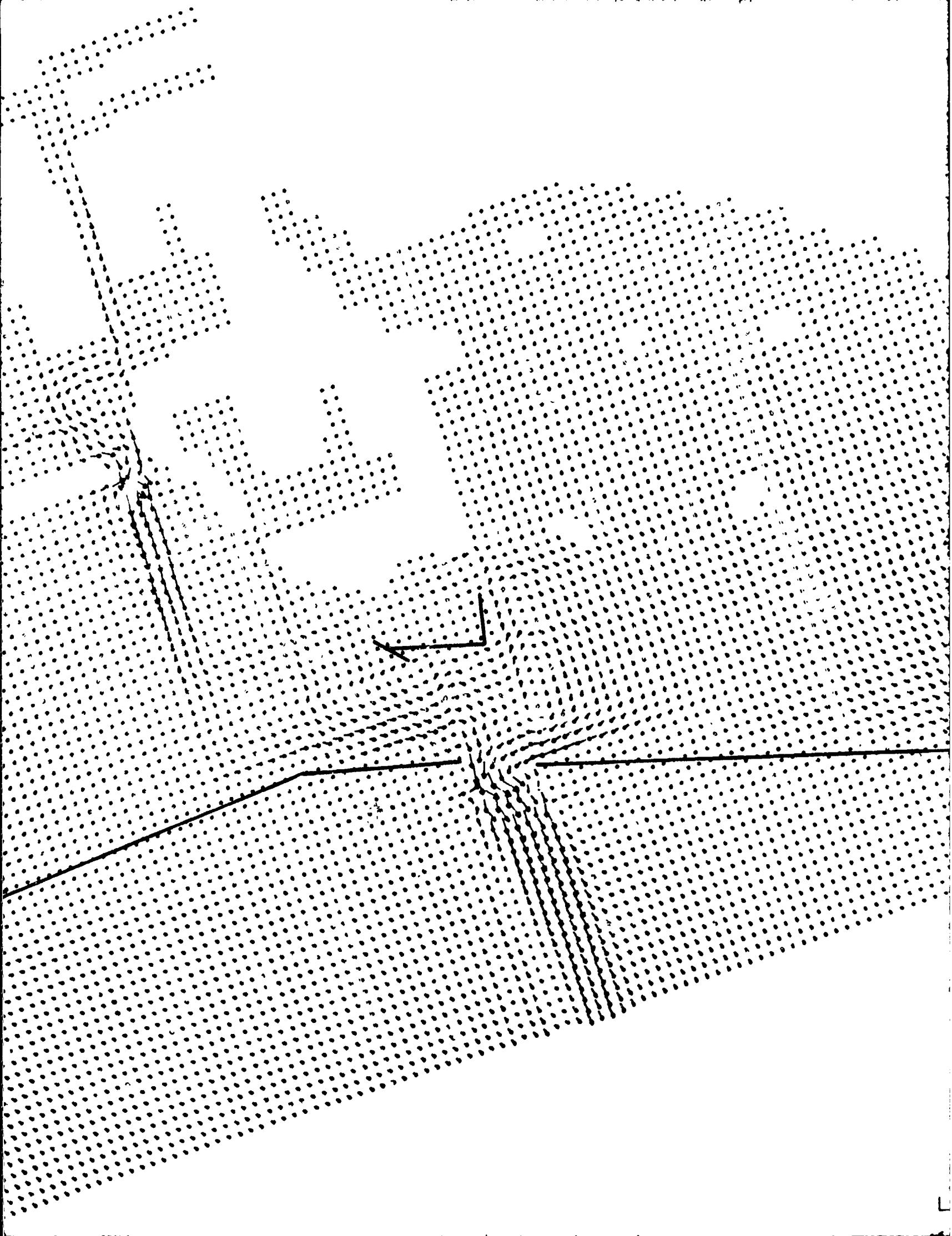
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

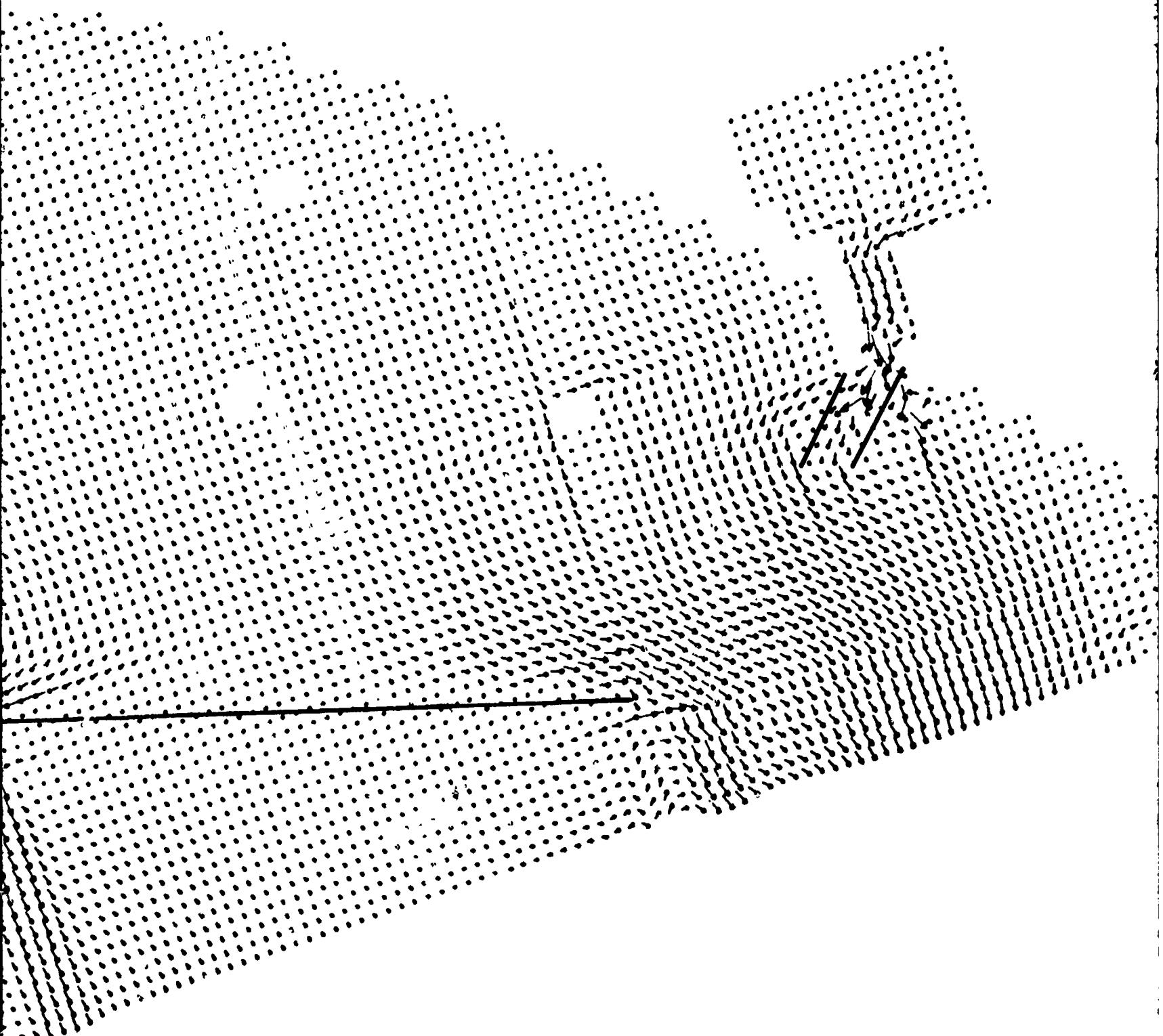
SURFACE CURRENT PATTERNS

SCHEME STFP 3, -82-FT CHANNEL

**SPRING TIDE
HOUR 22**





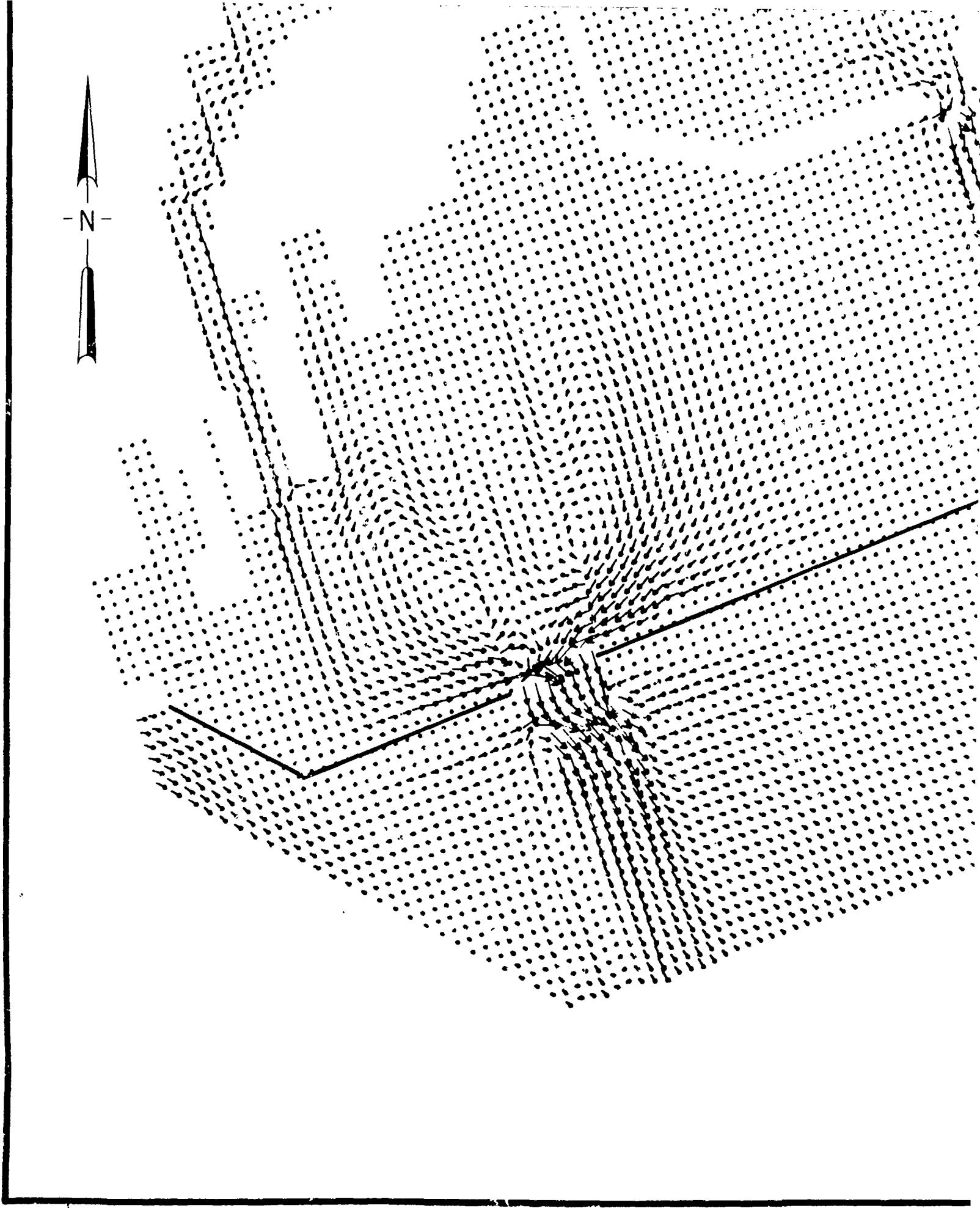


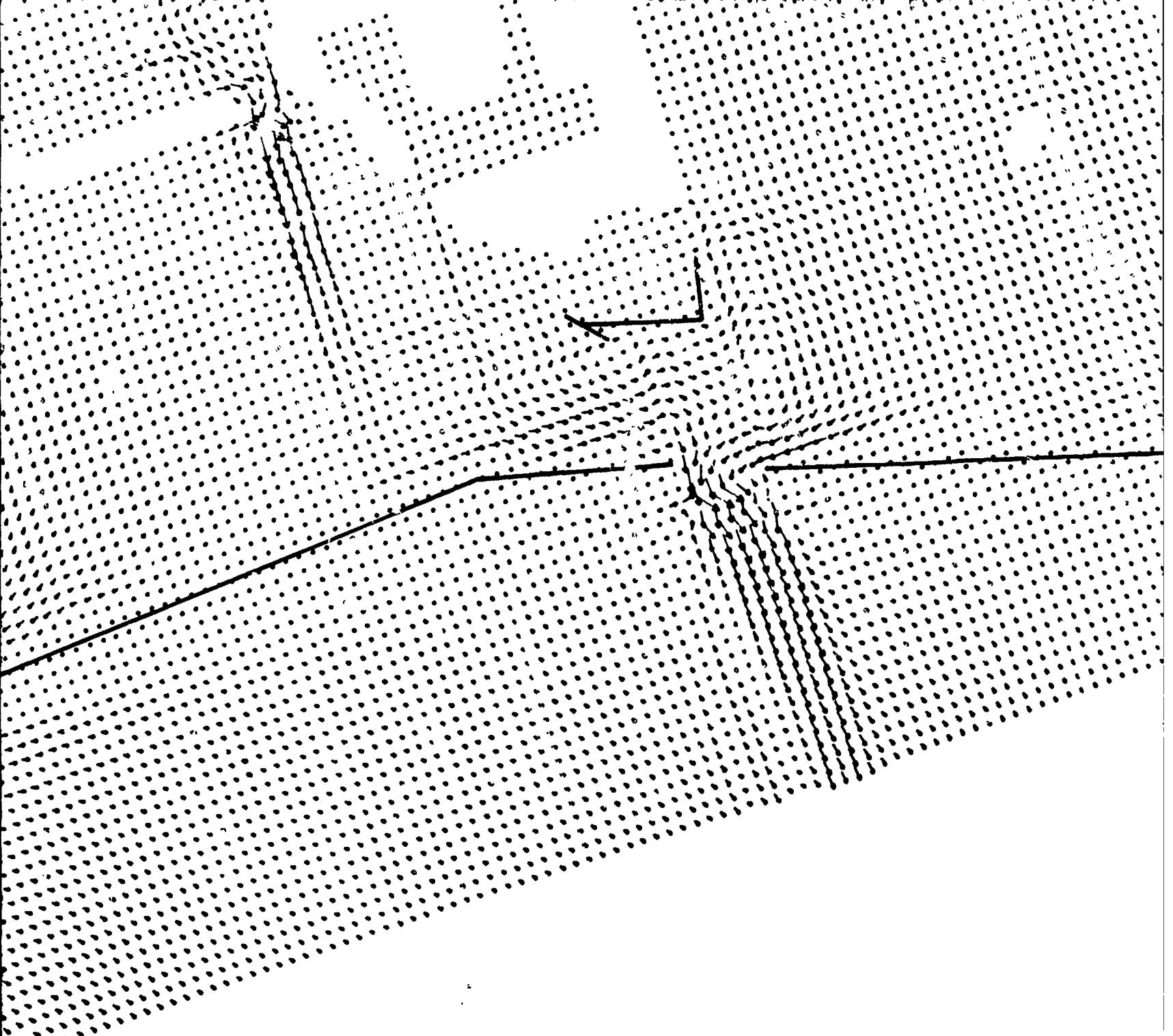
VELOCITY SCALE

1	0	1	2	3

PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS



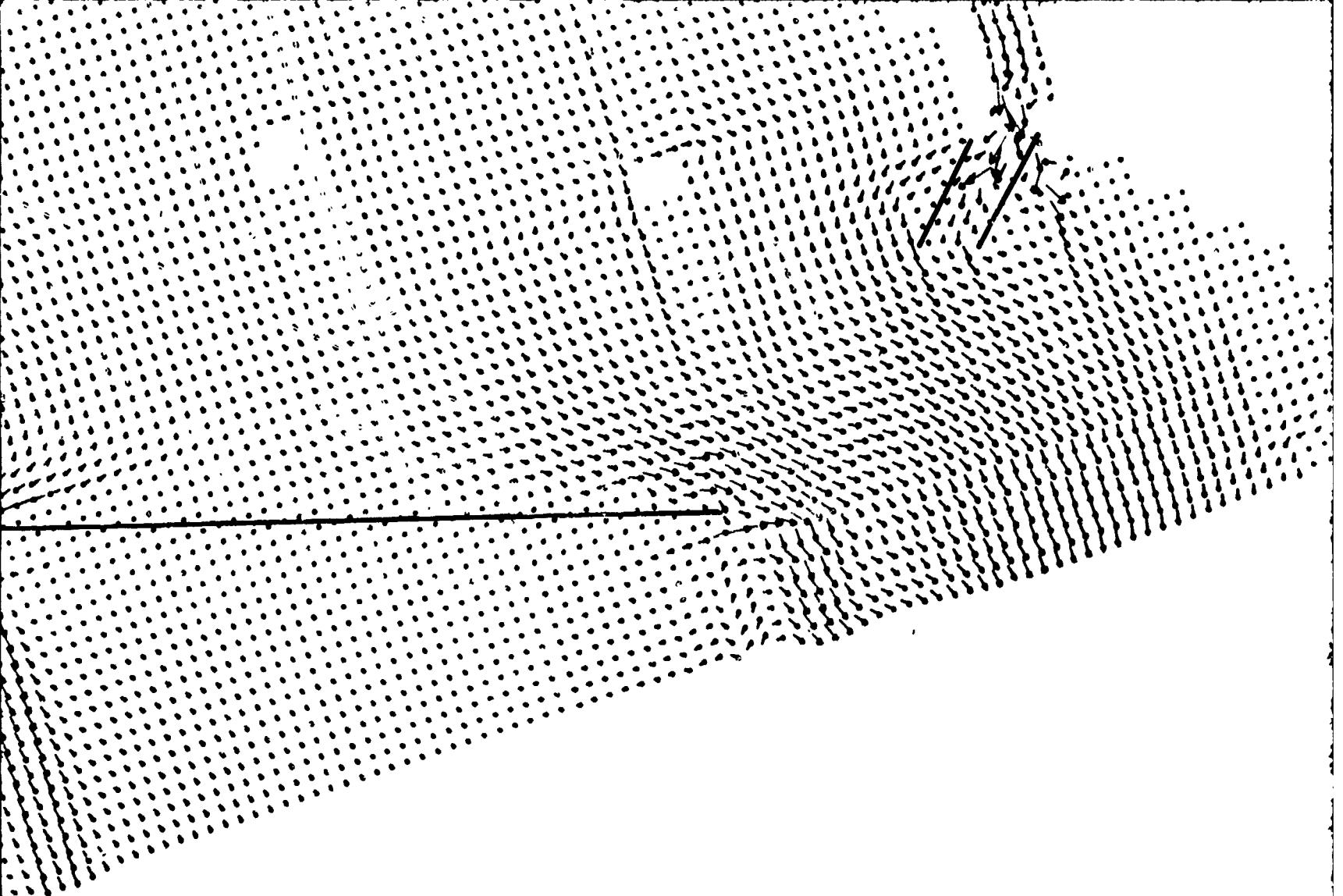


SCALE IN FEET

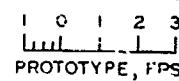
2000 0 2000 4000

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51



VELOCITY SCALE

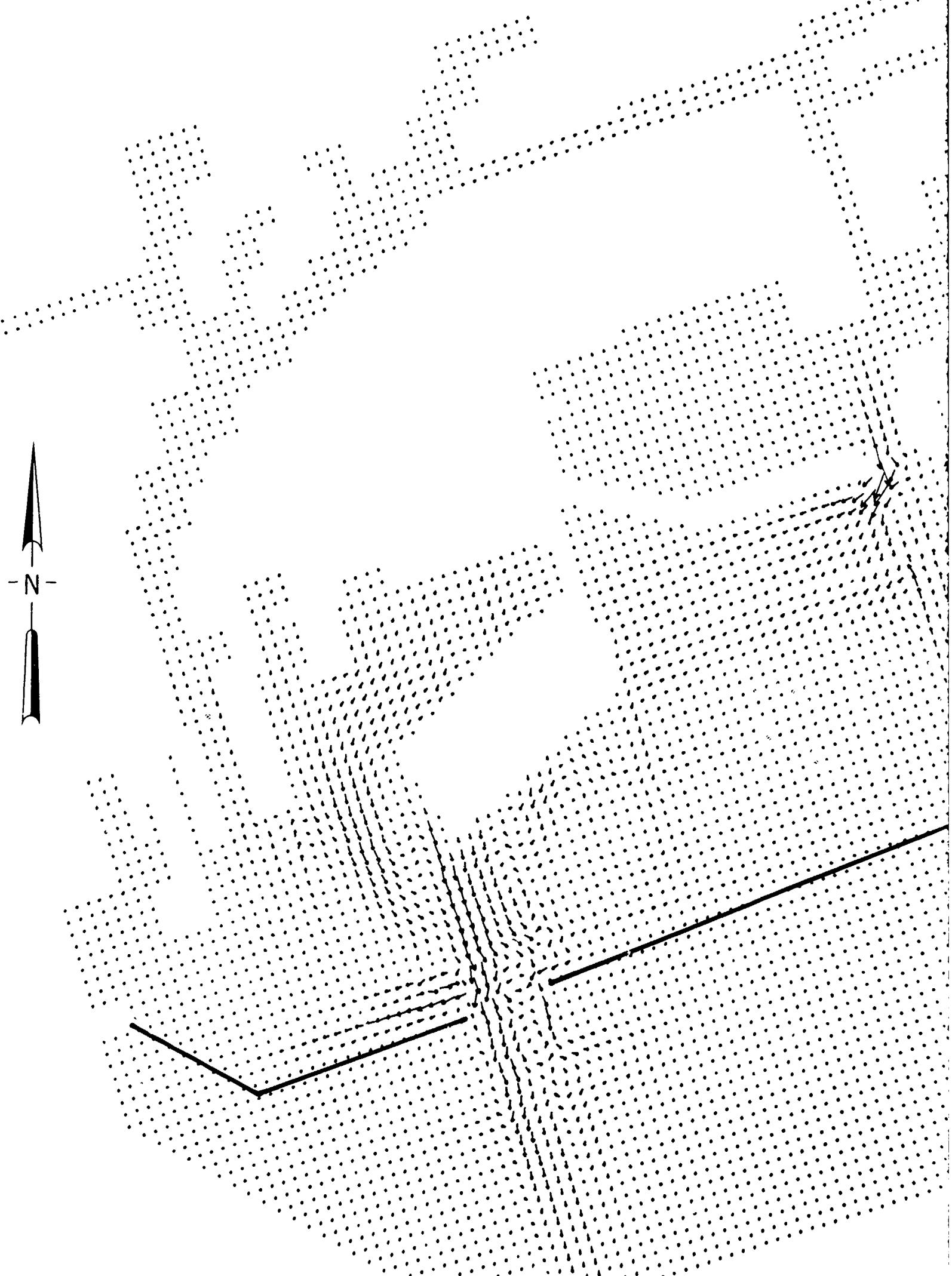


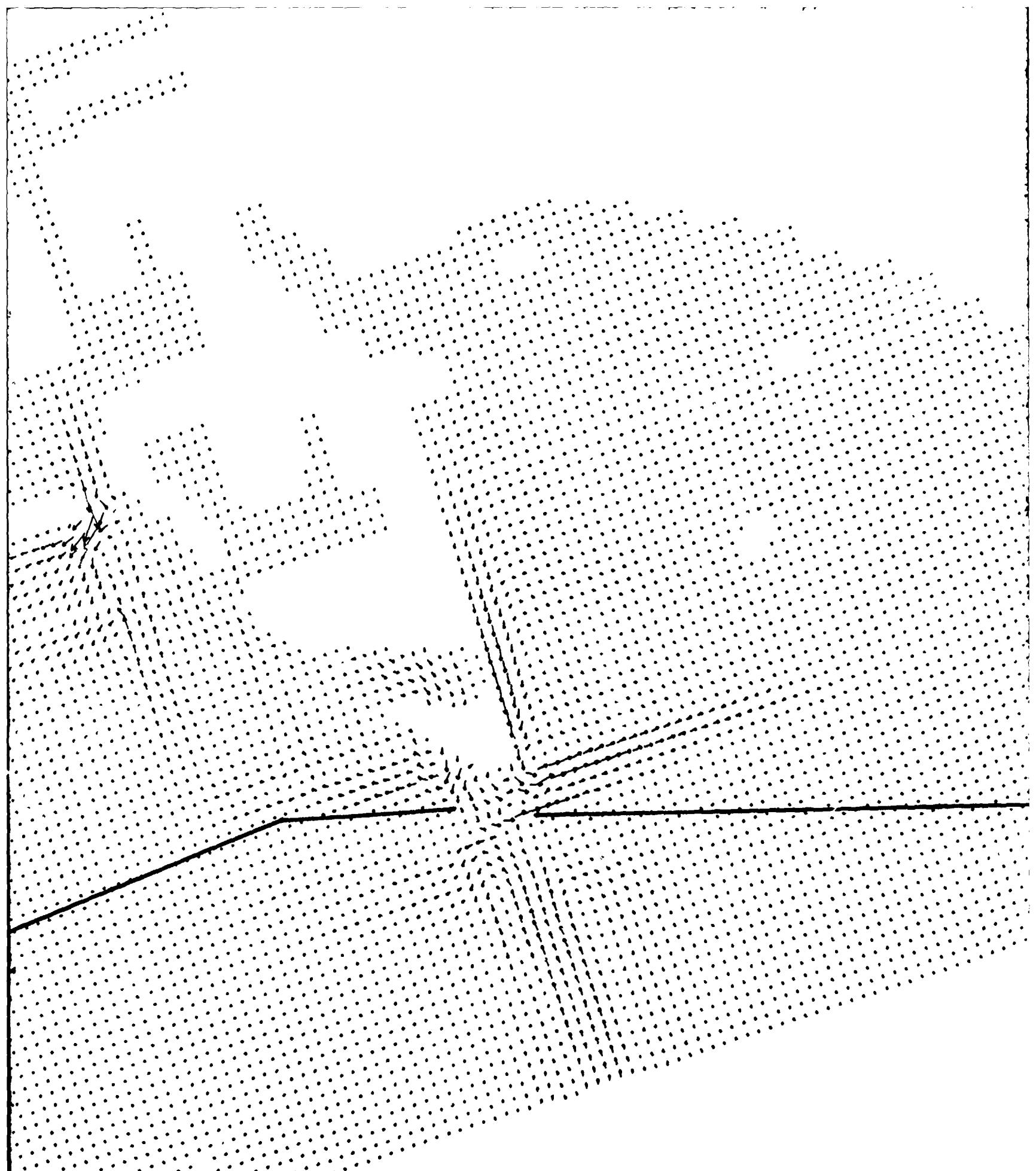
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

SURFACE CURRENT PATTERNS

SCHEME STFP 3, -82-FT CHANNEL

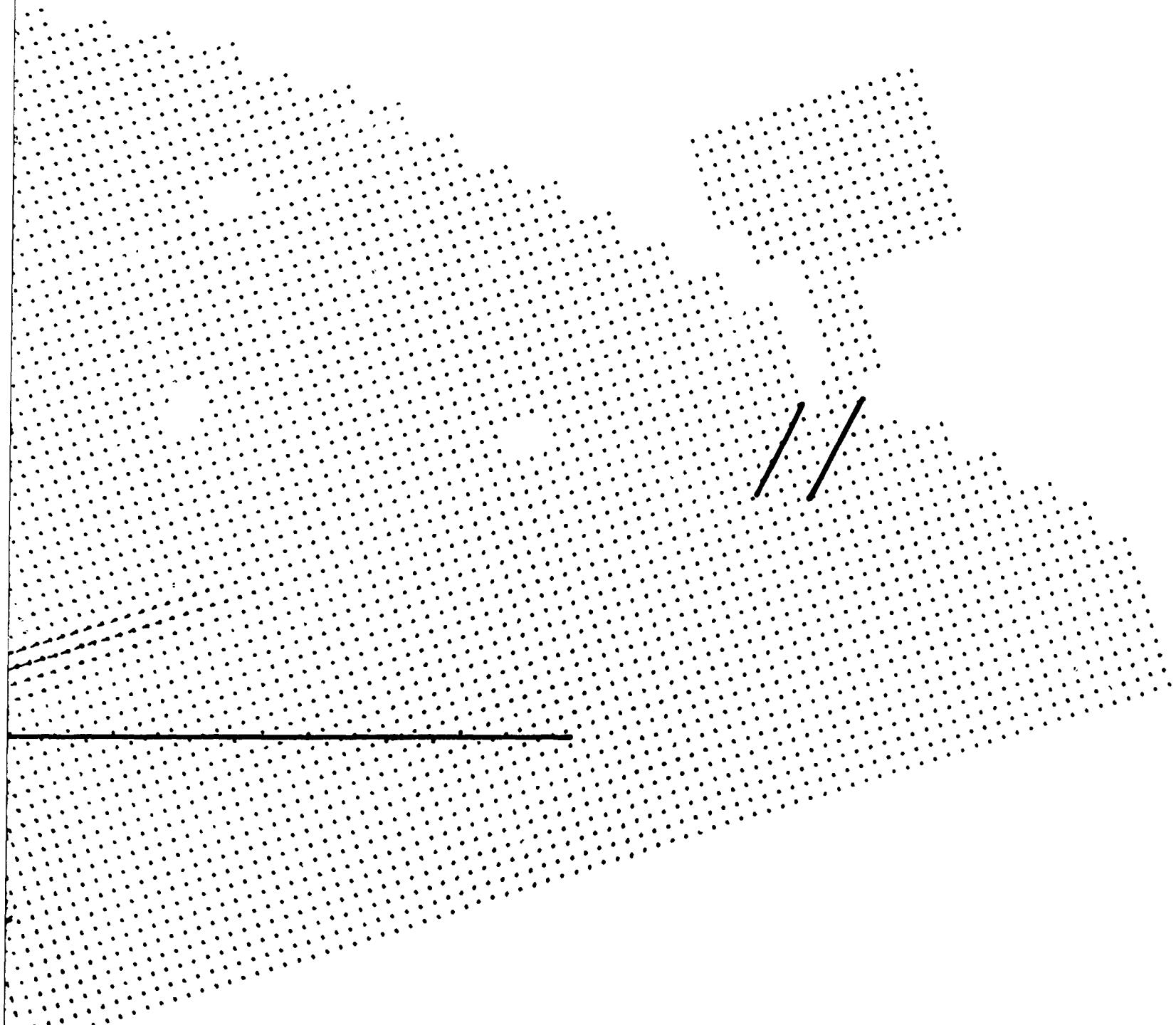
SPRING TIDE
HOUR 24





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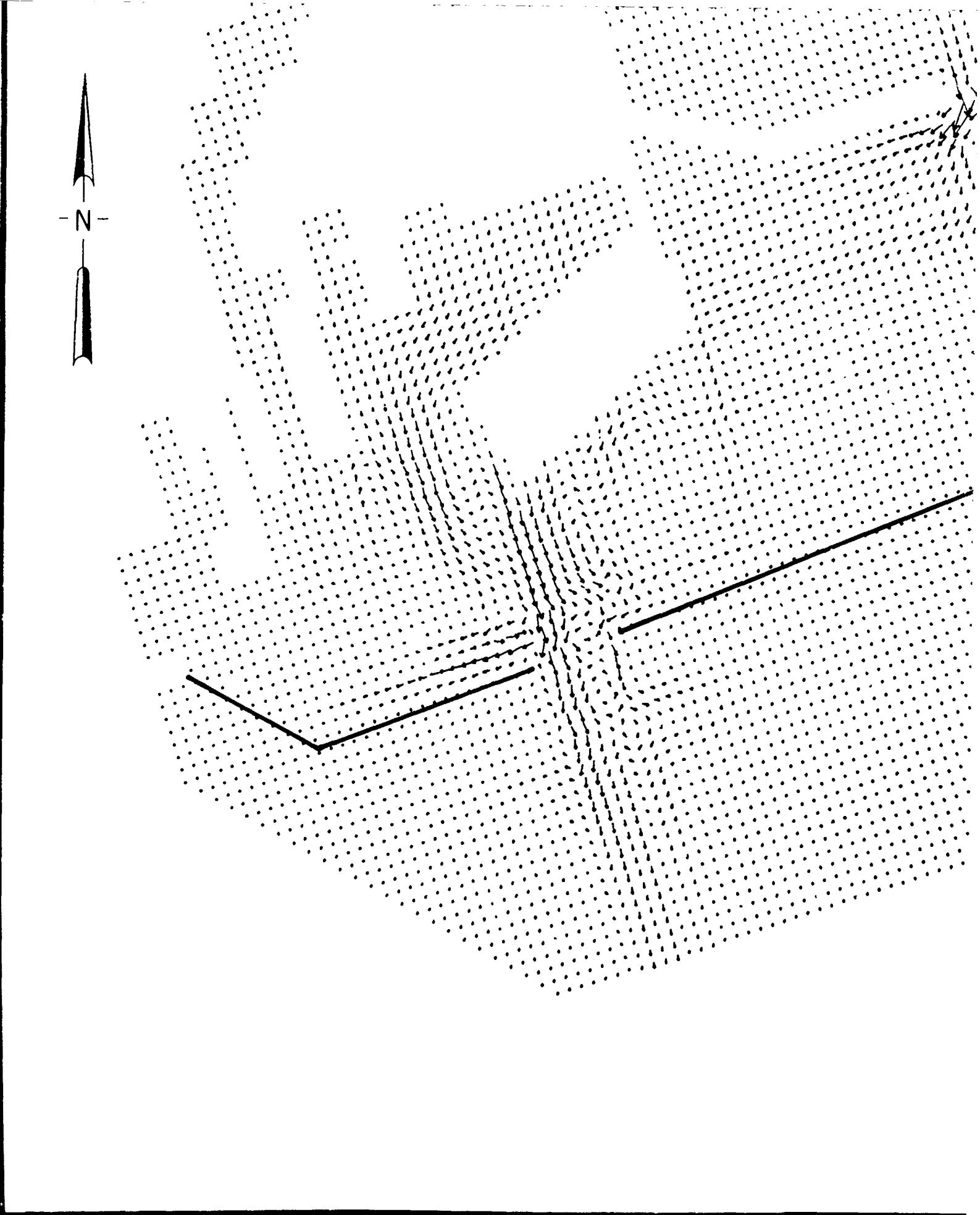
VELOCITY SCALE

1	0	1	2	3

PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN



11

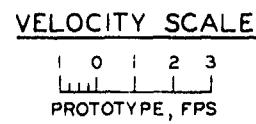
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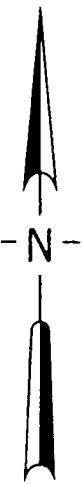
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)

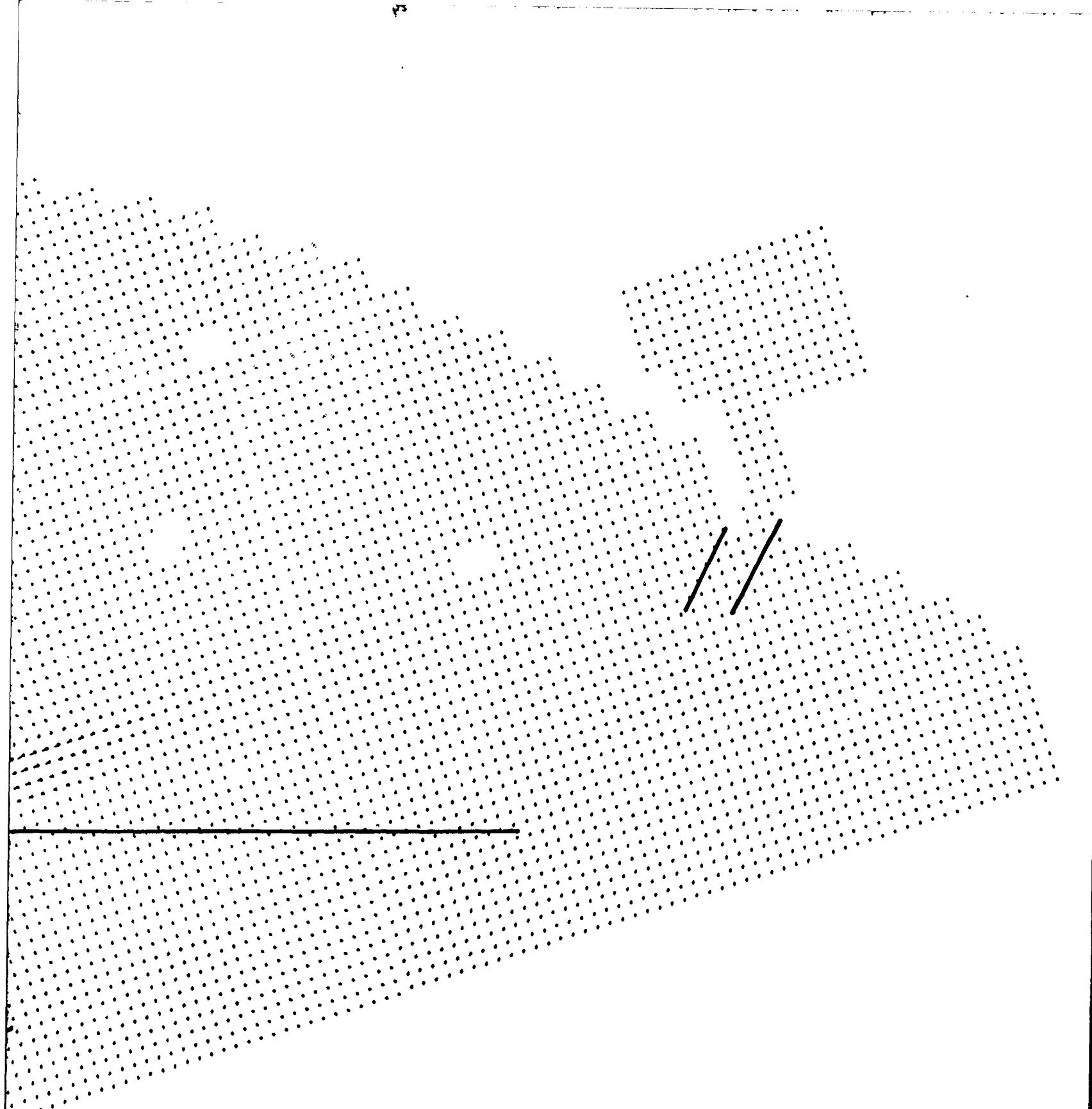


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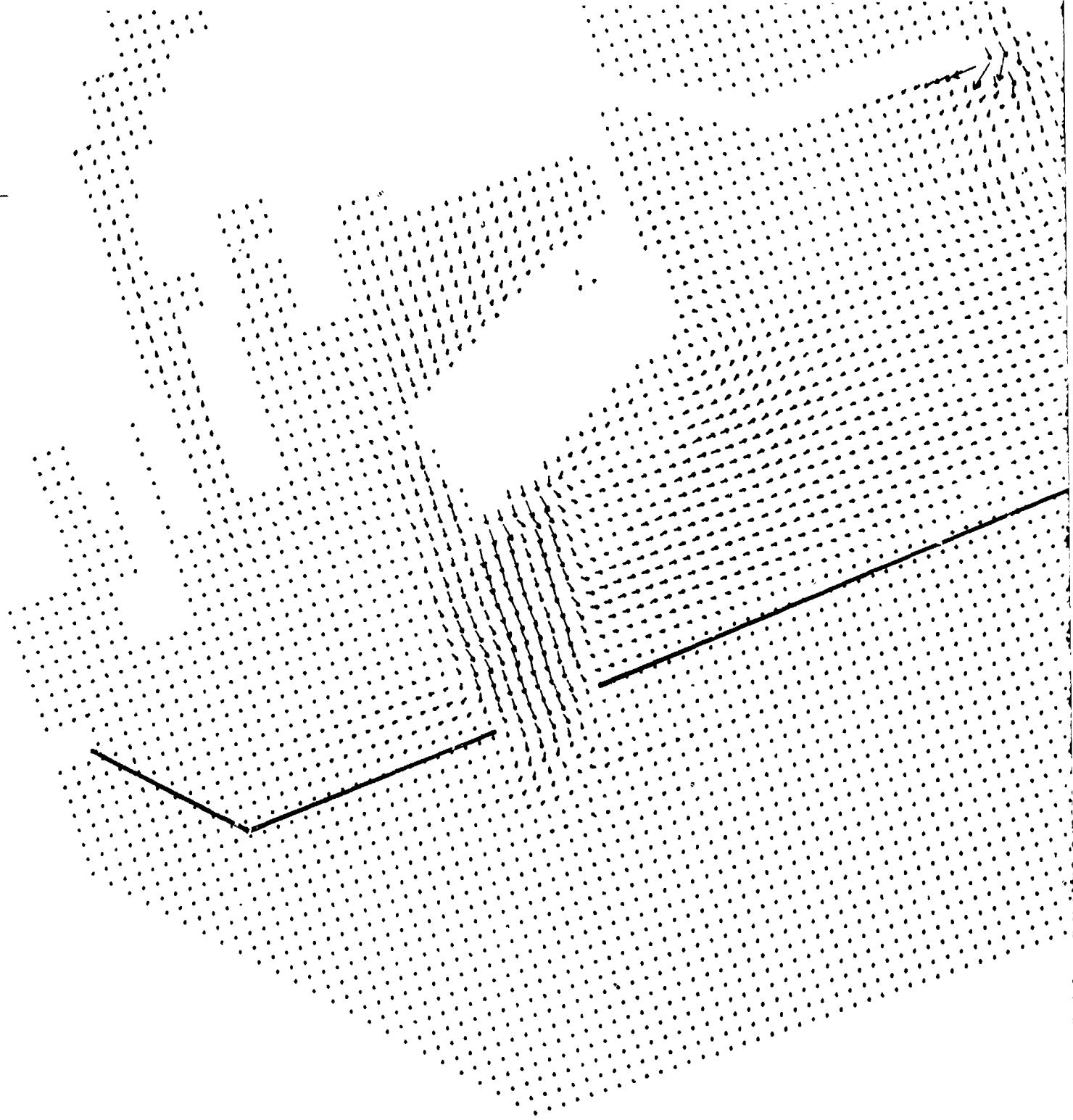
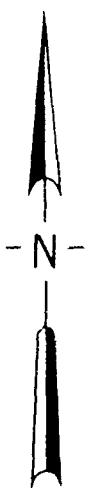
VELOCITY SCALE

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PROTOTYPE, FPS

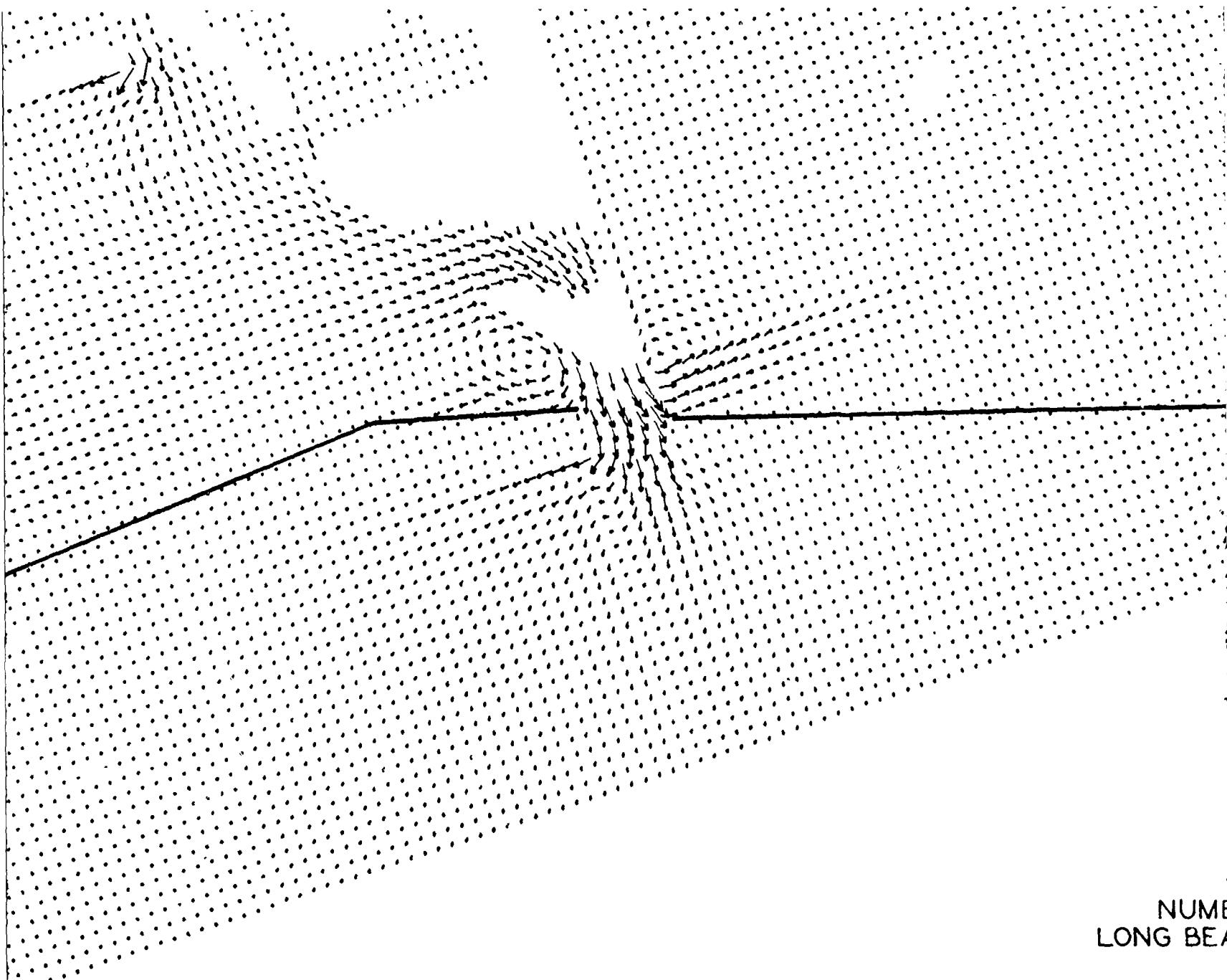
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN PLAN 1A-2**



11

A -

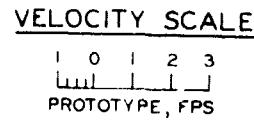


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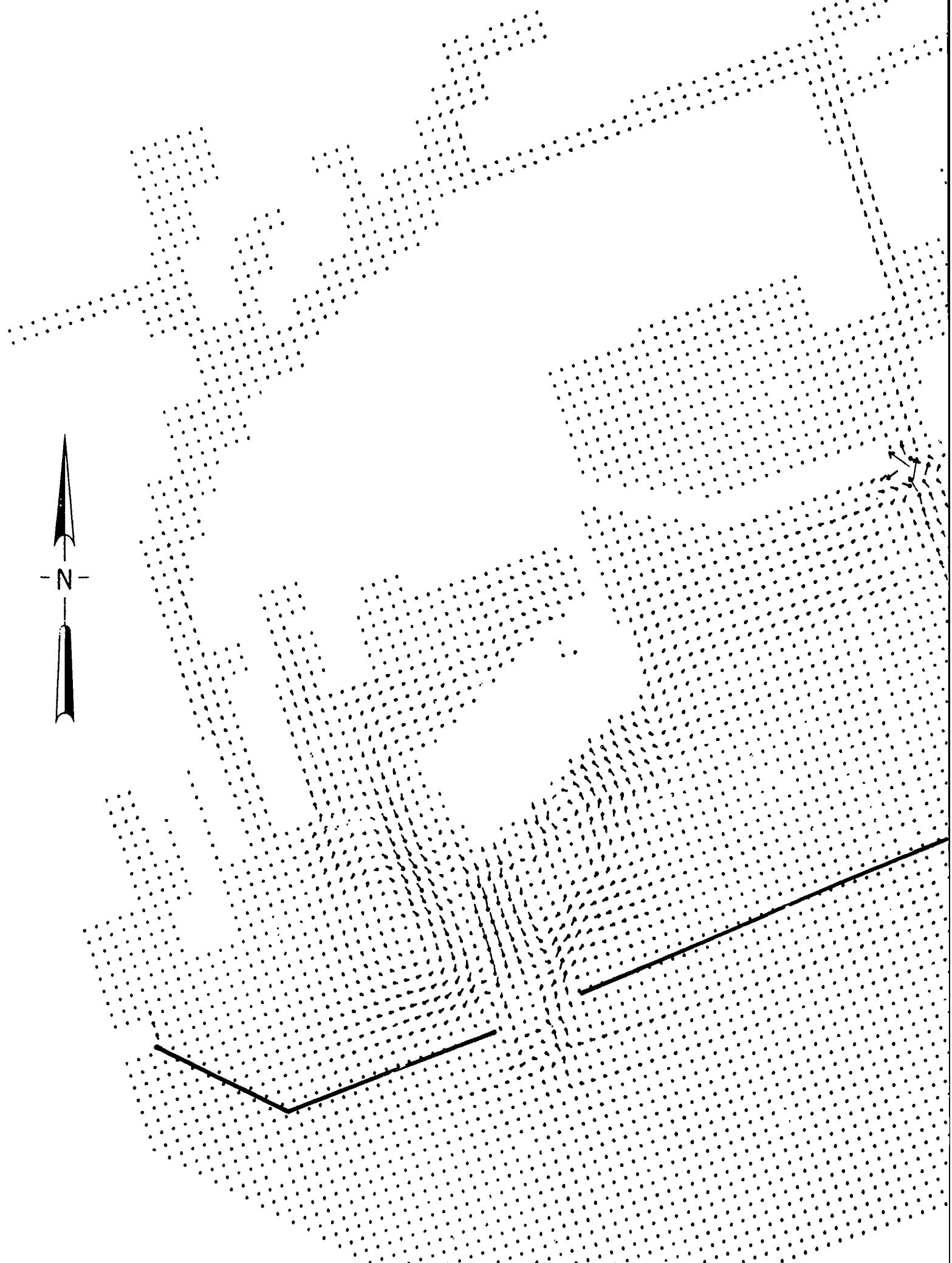
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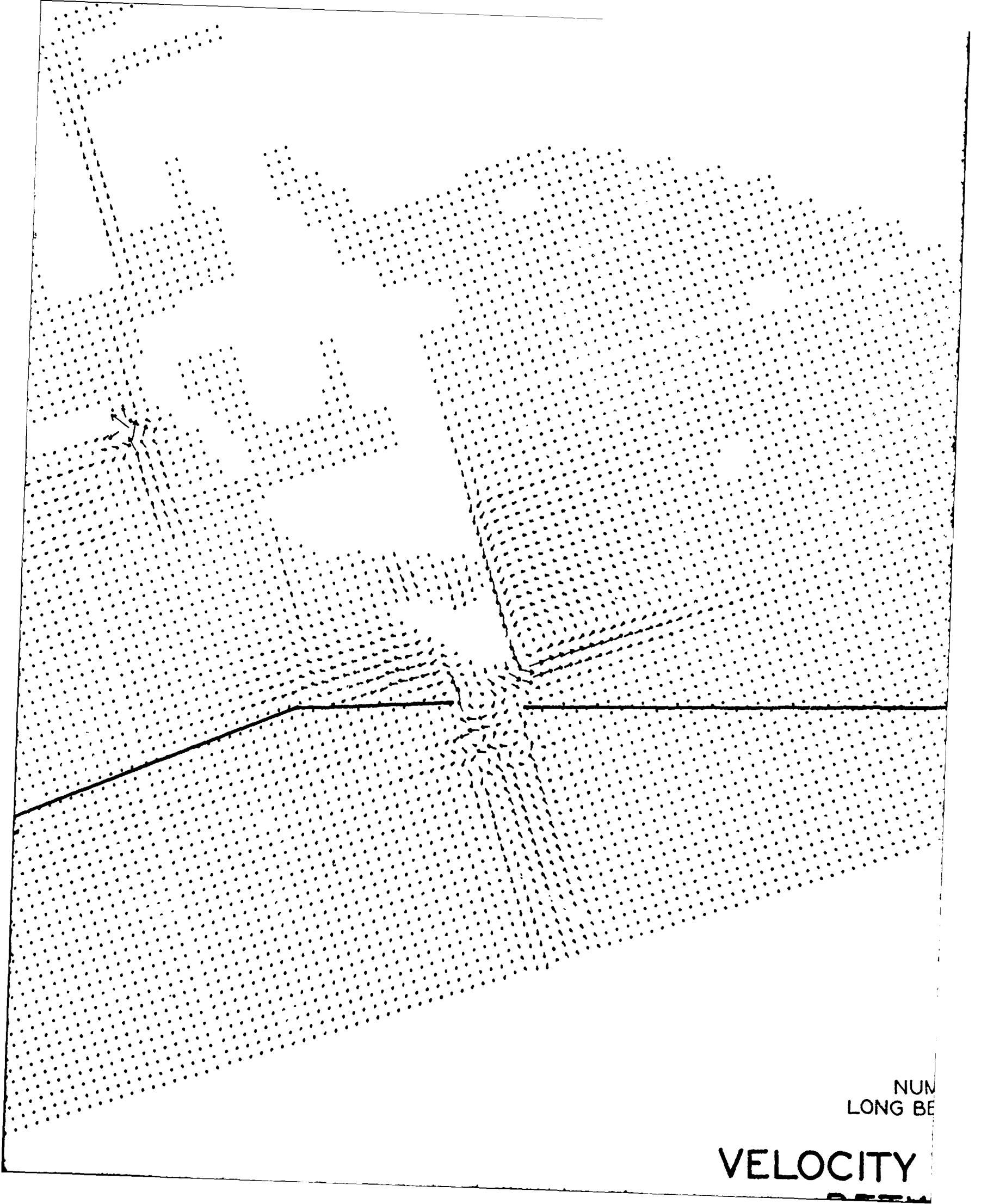


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

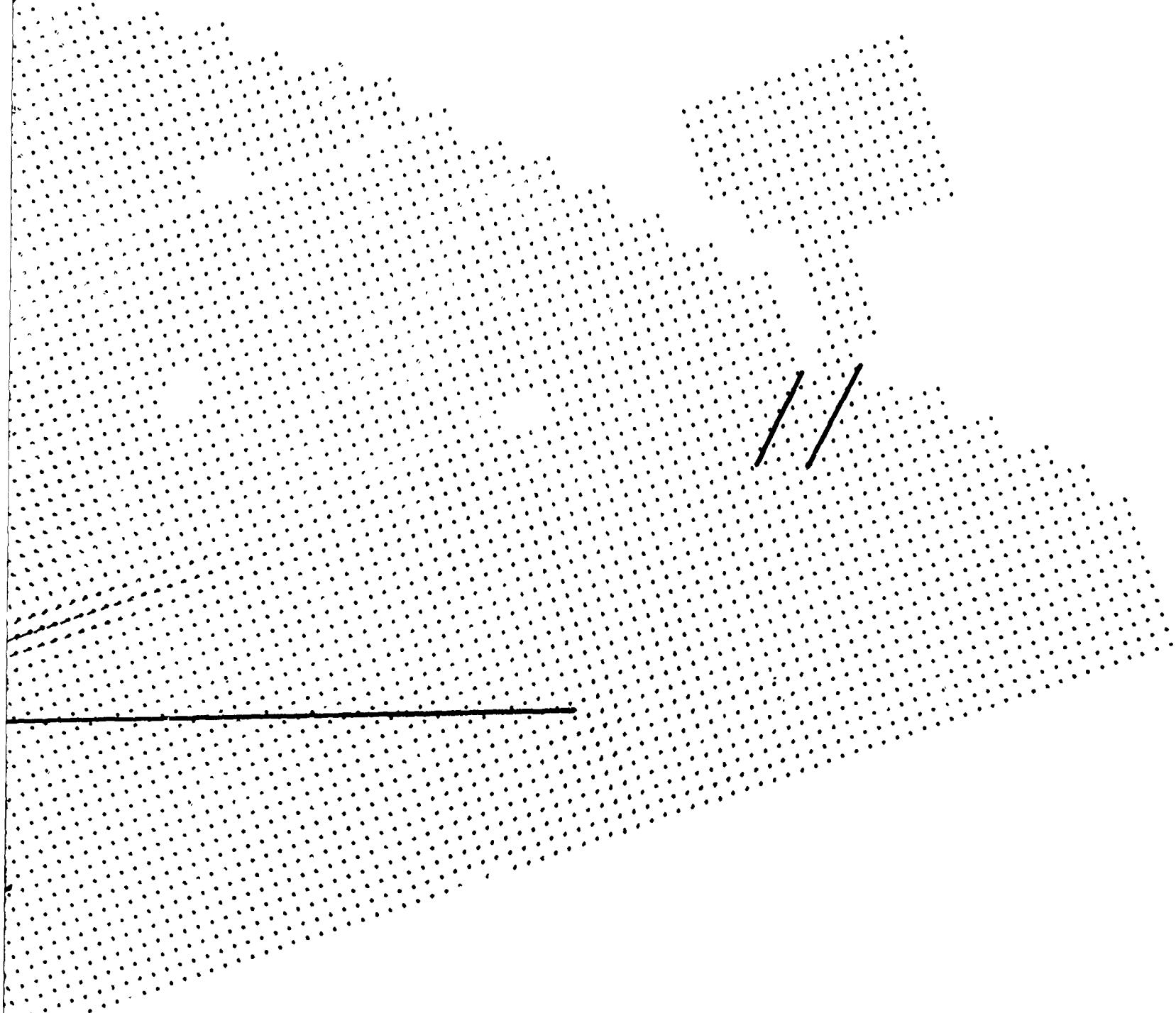
SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)



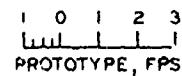


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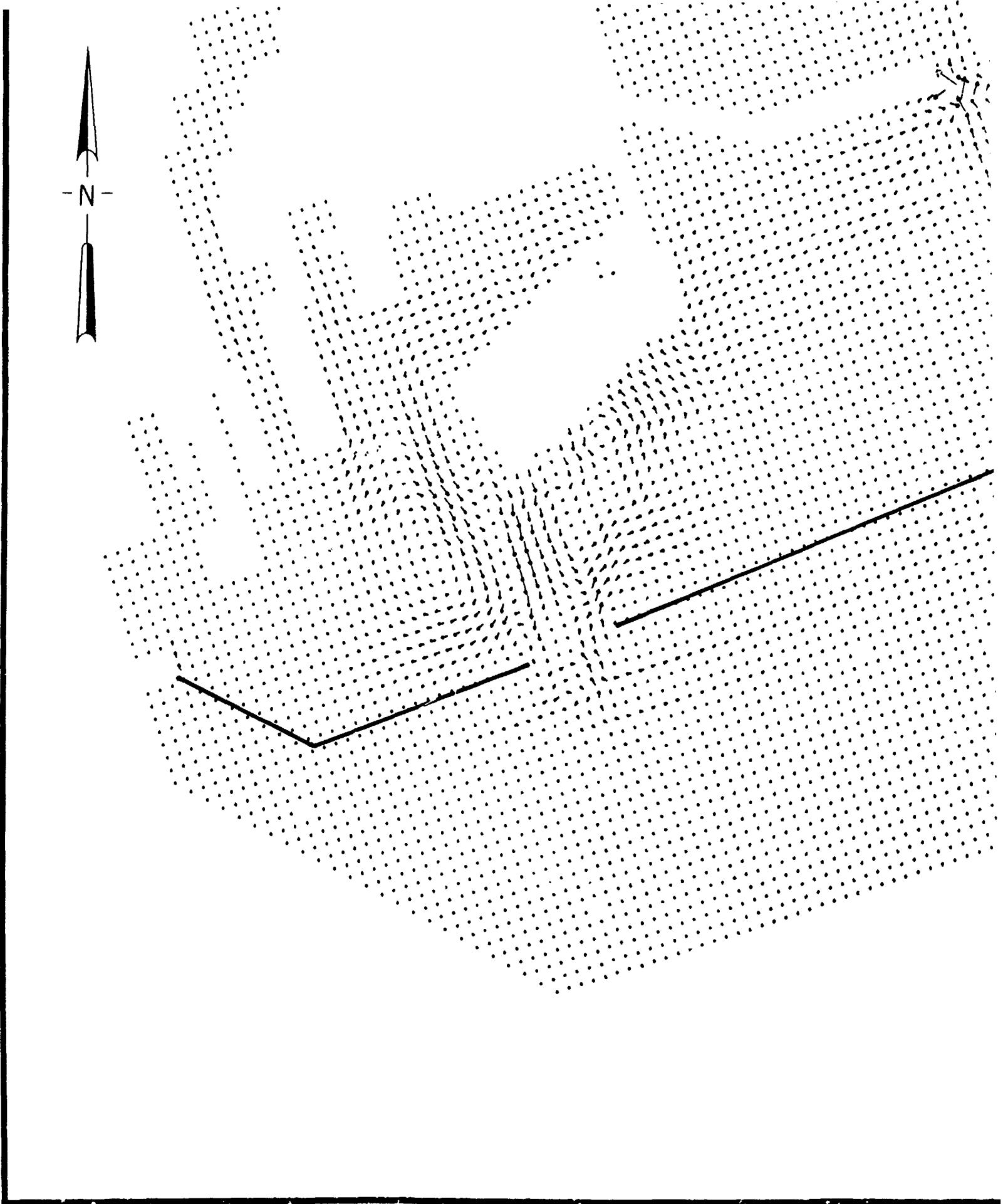


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN



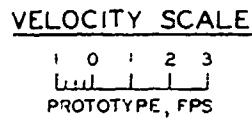
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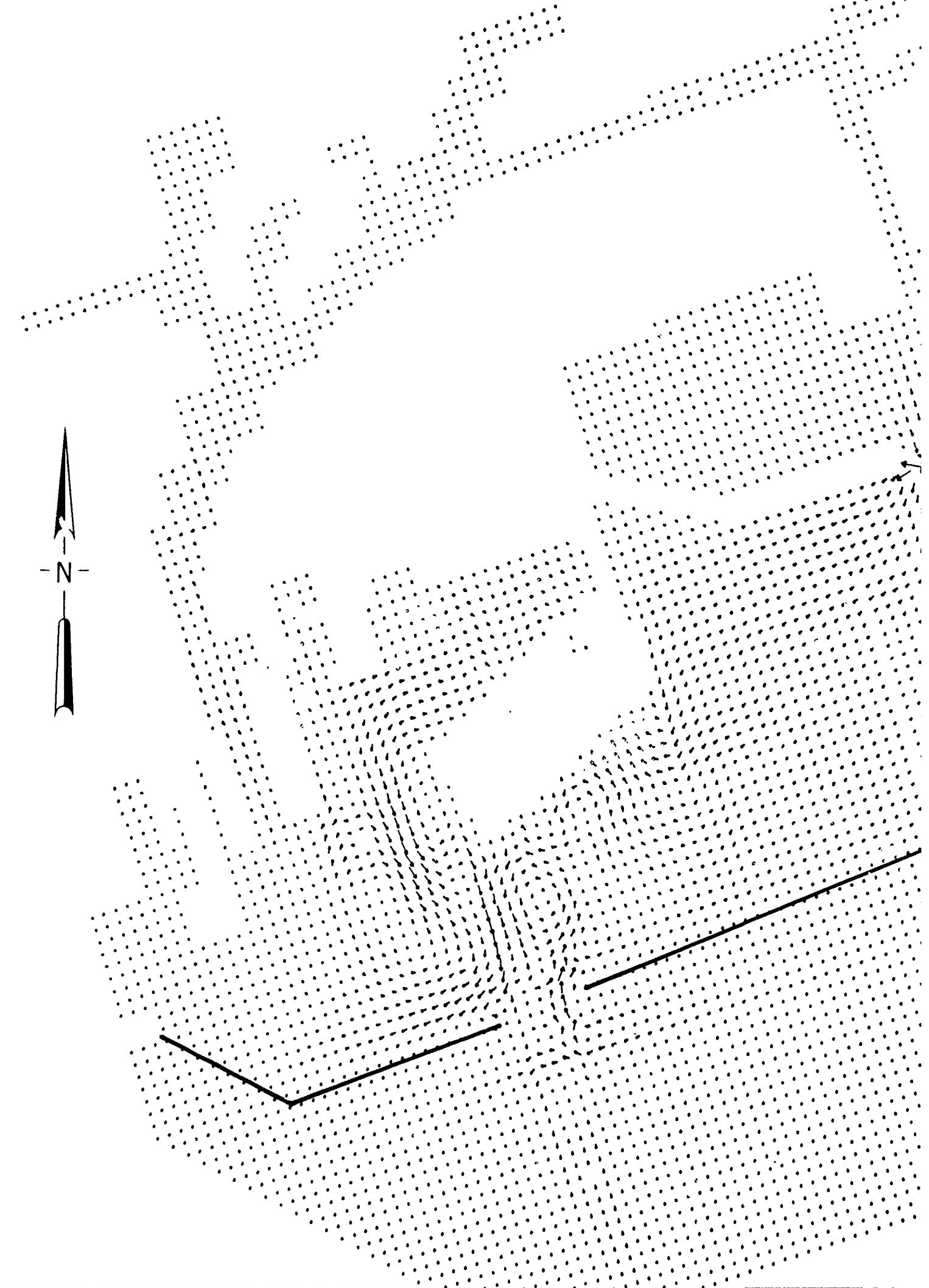
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

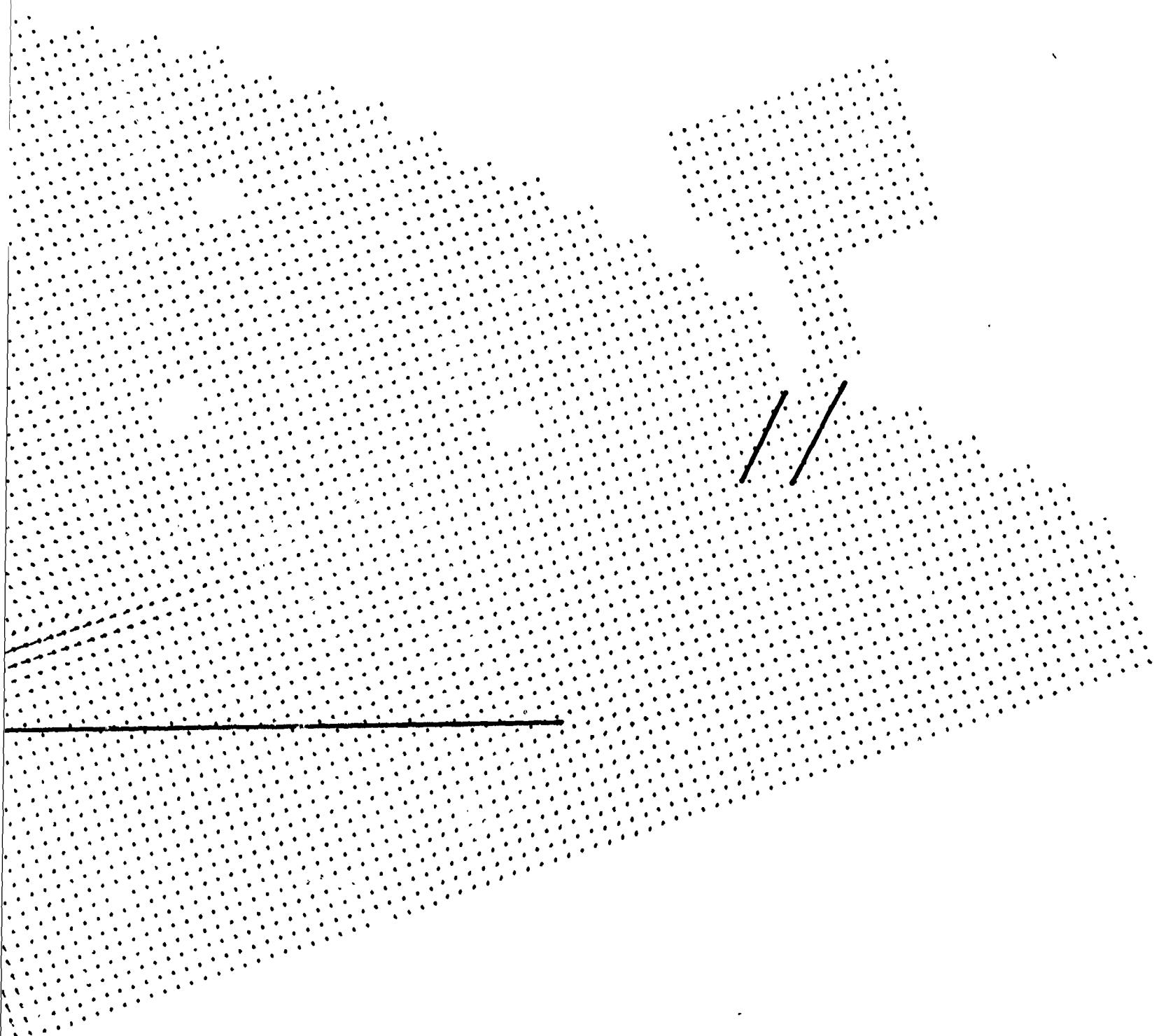
VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)



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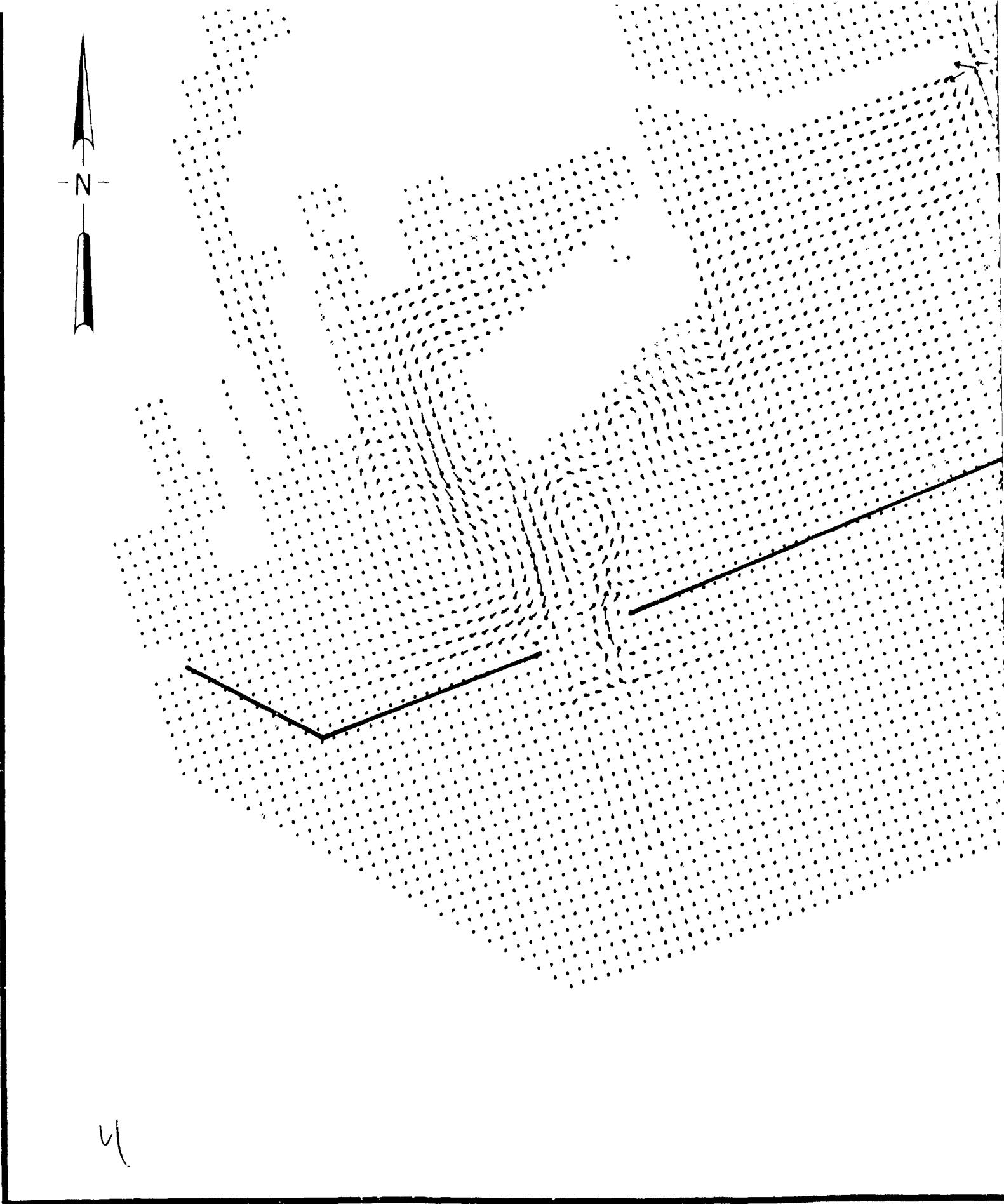


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN

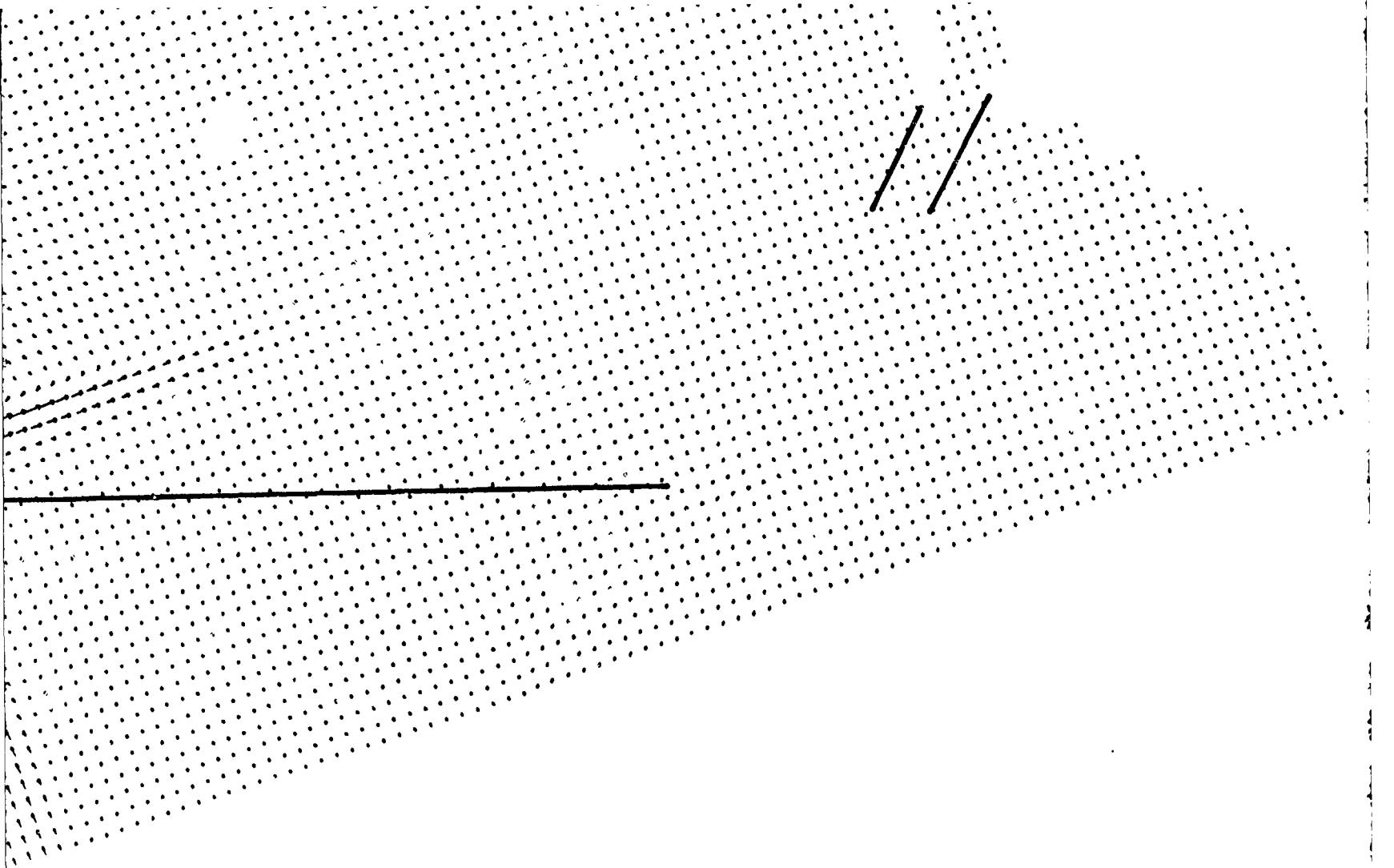


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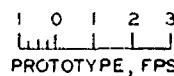
SCALE IN FEET



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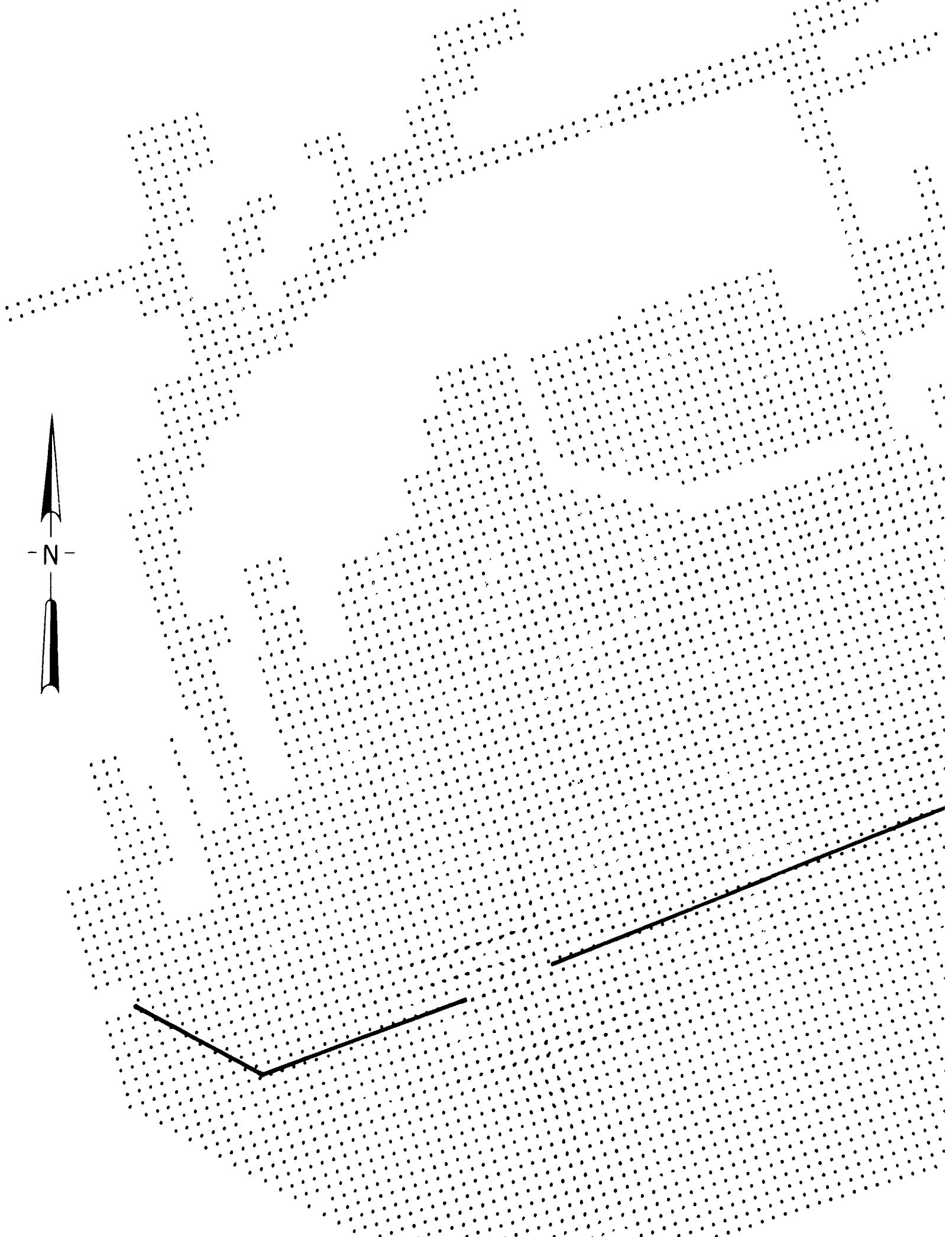
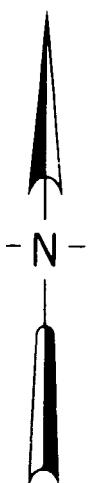
VELOCITY SCALE

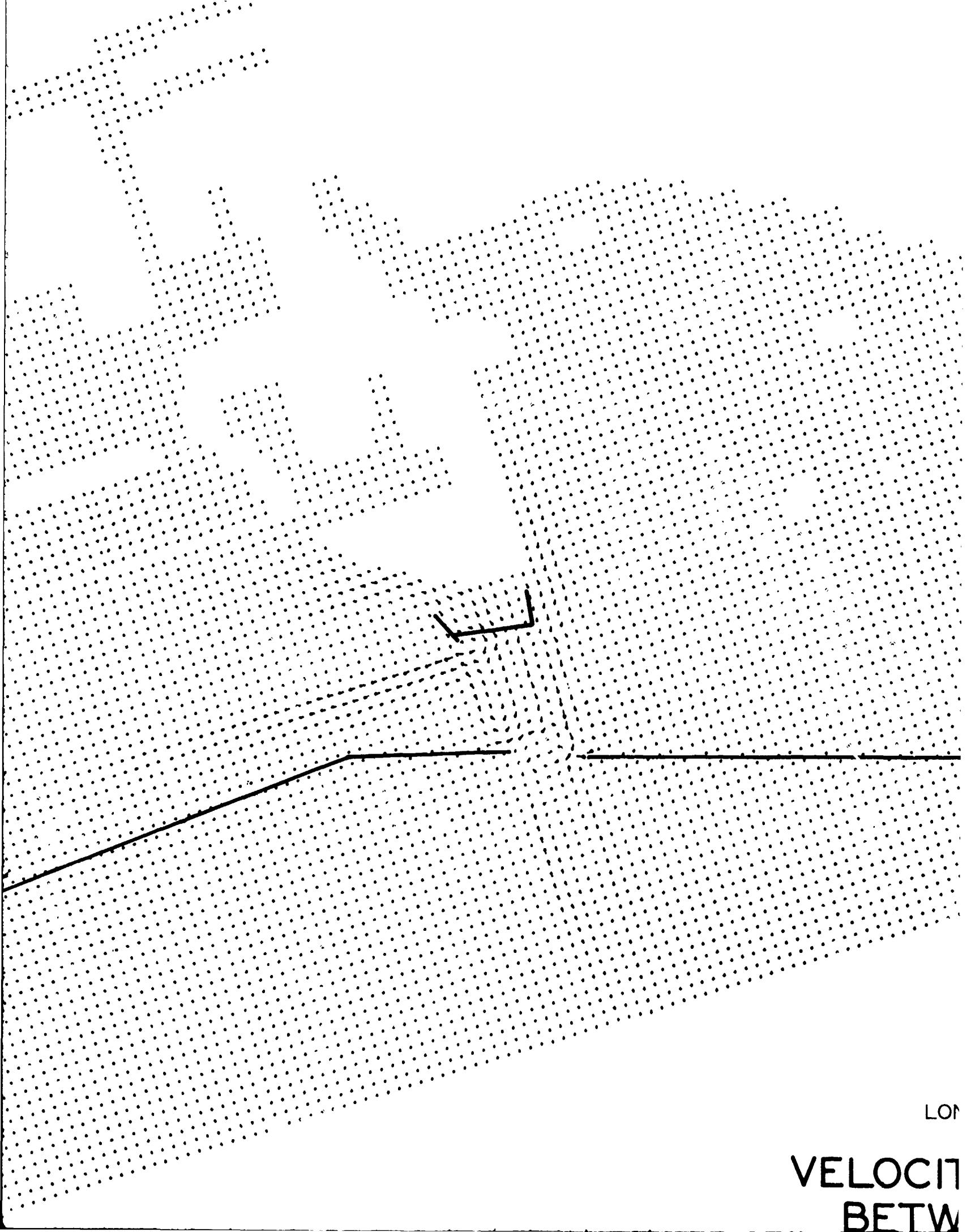


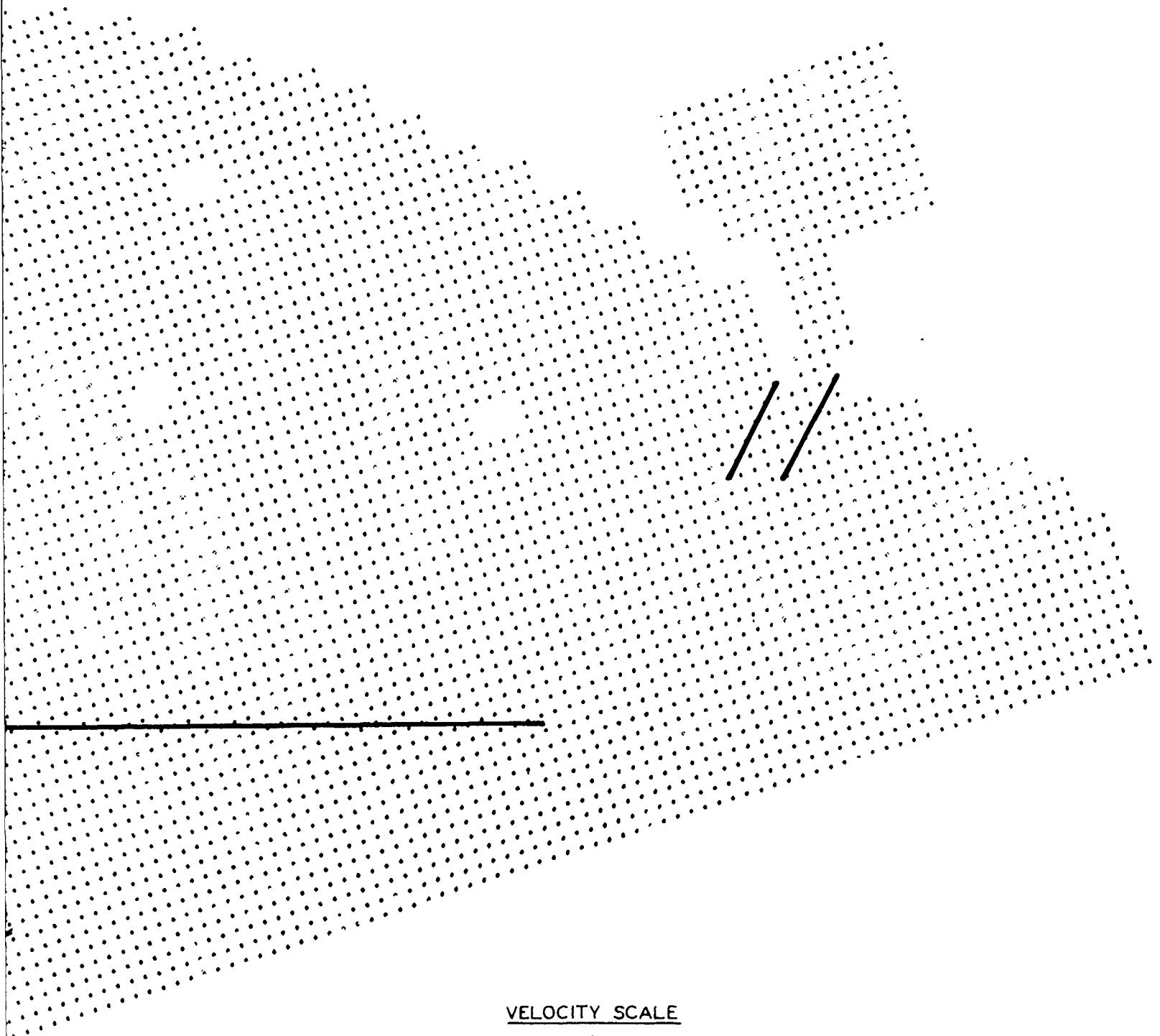
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN PLAN 1A-2 AND EXISTING CONDITIONS

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)



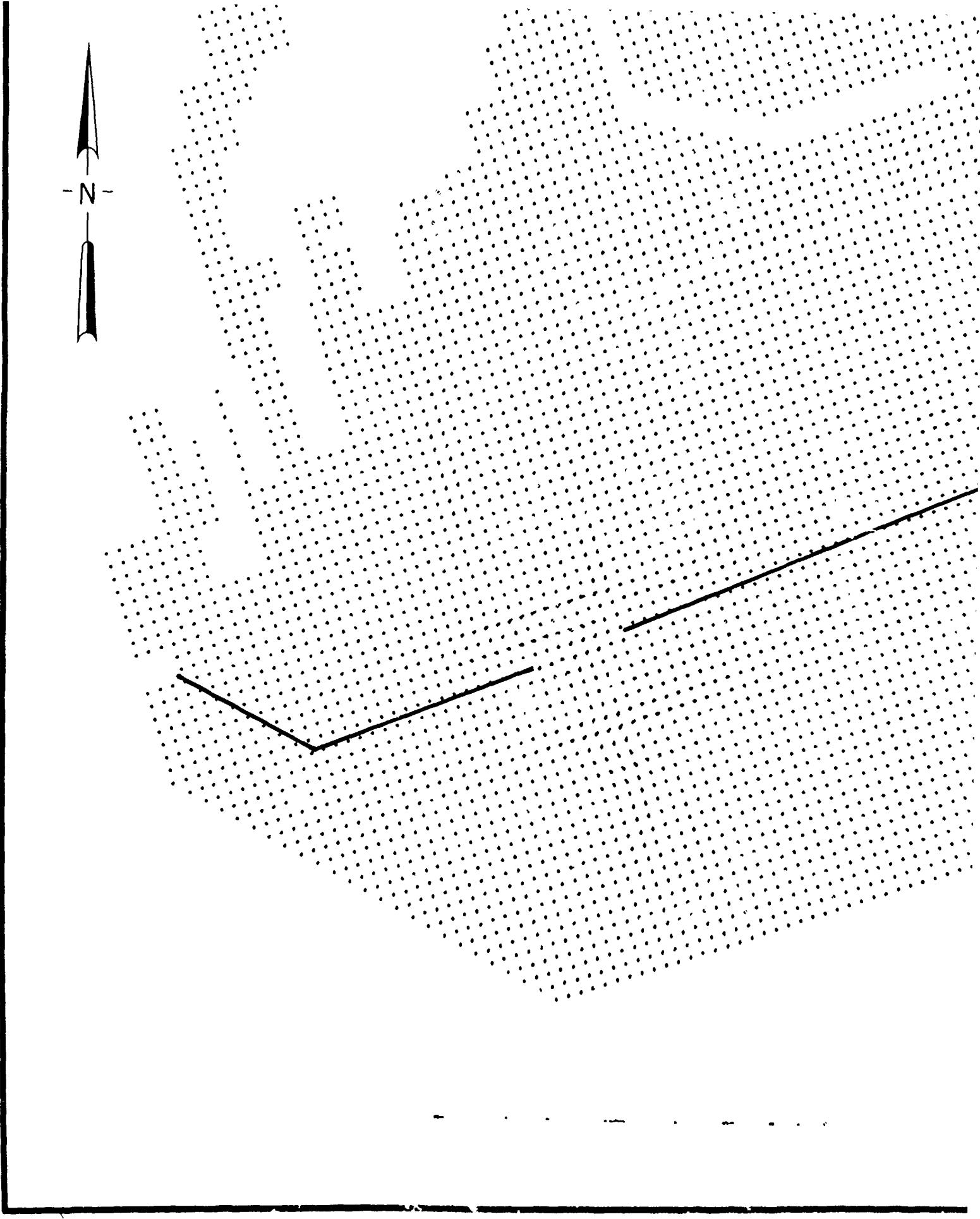




VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL 300-FT OPENING



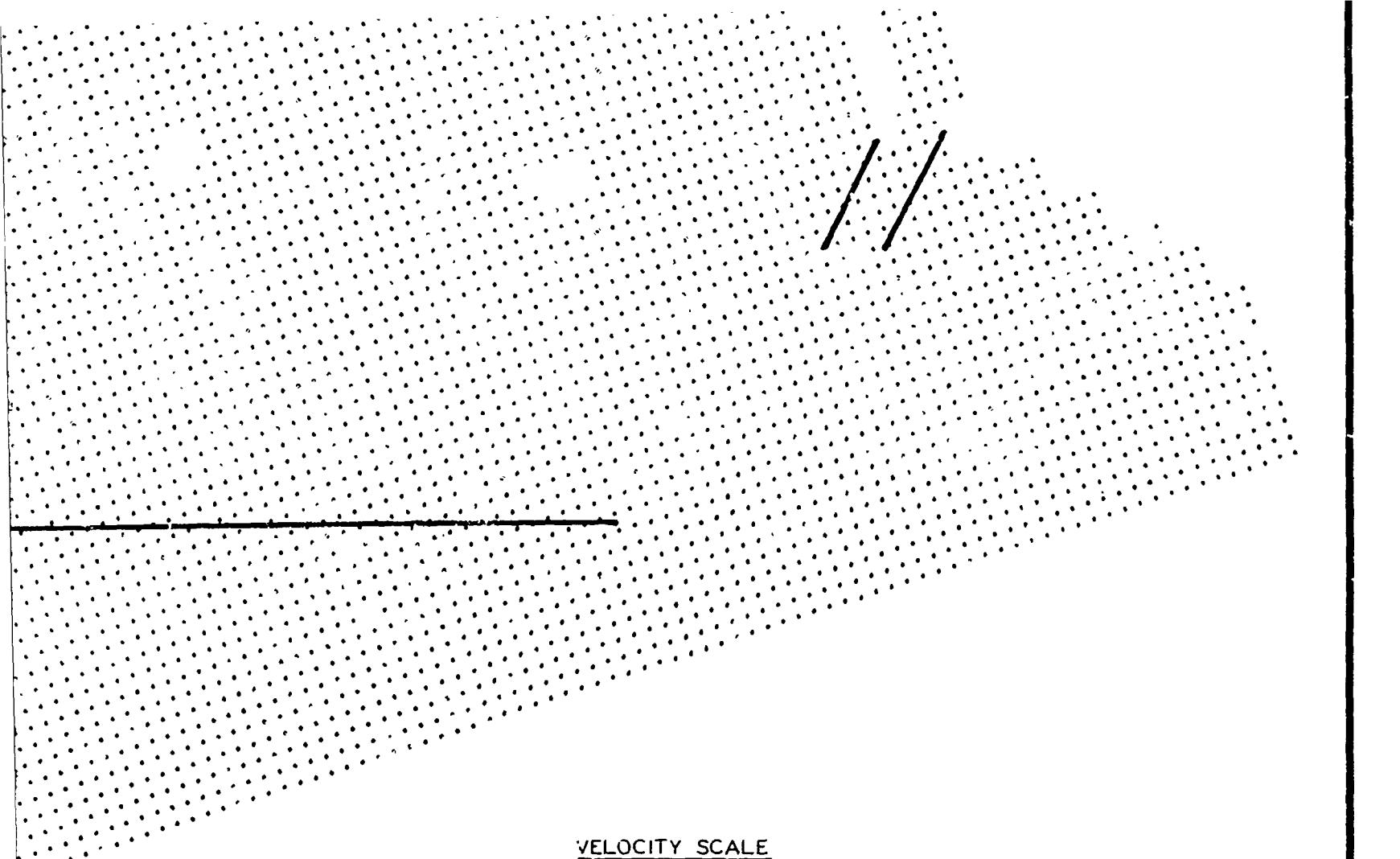
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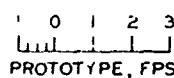
SCALE IN FEET

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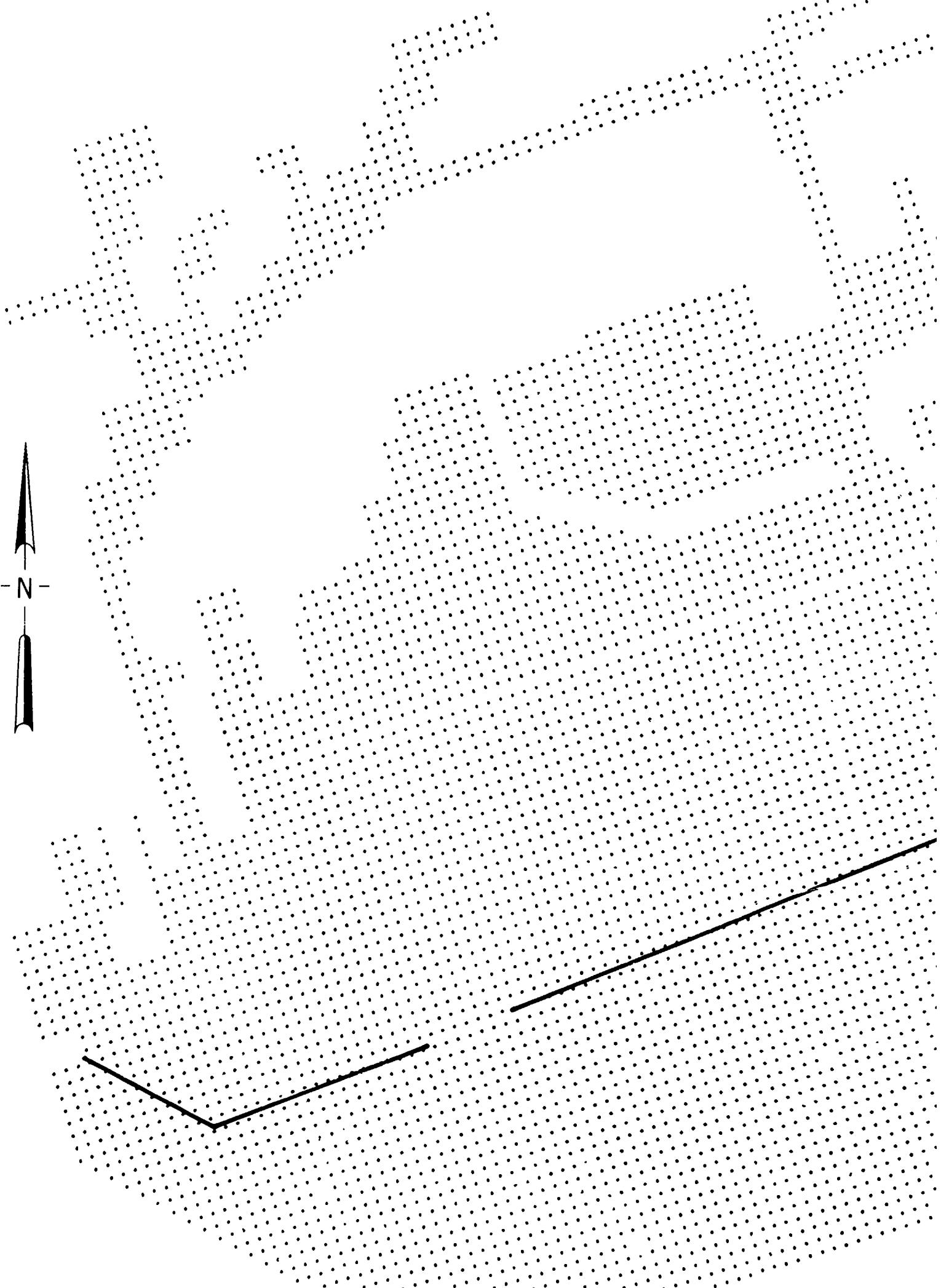
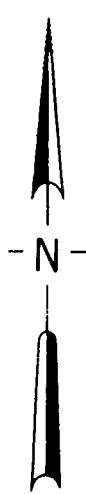
VELOCITY SCALE

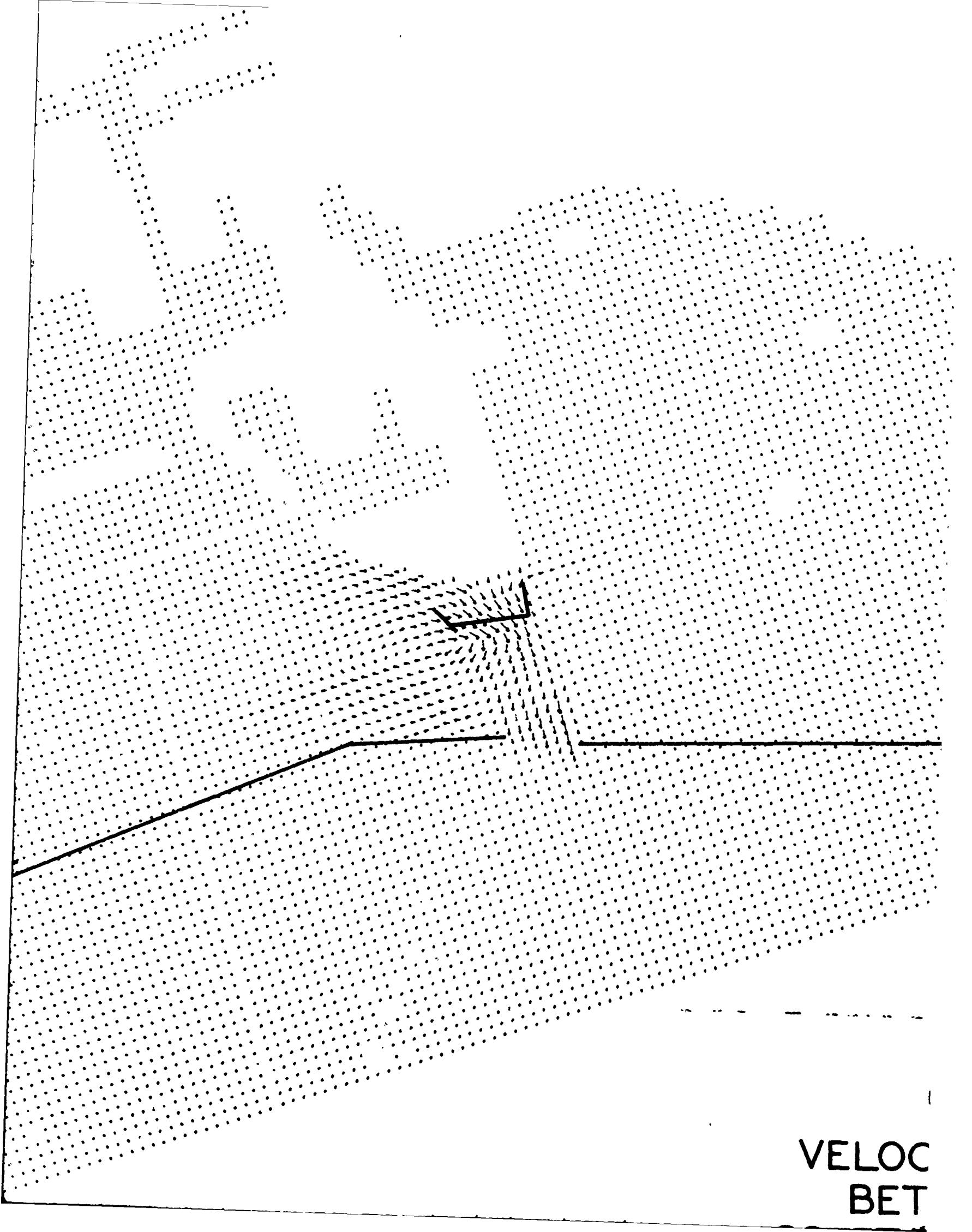


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

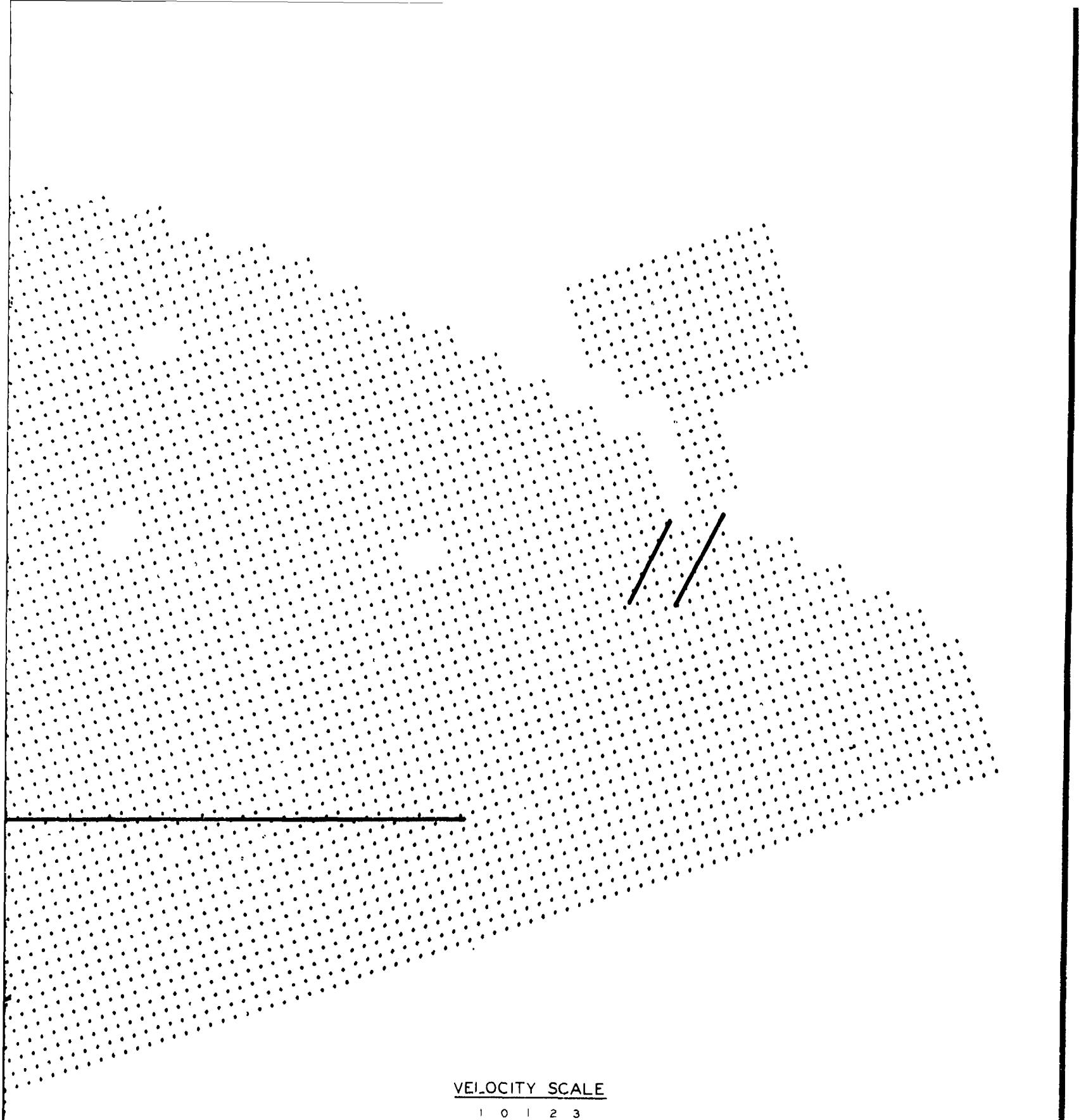
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 300-FT OPENING,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)





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VELOCITY SCALE

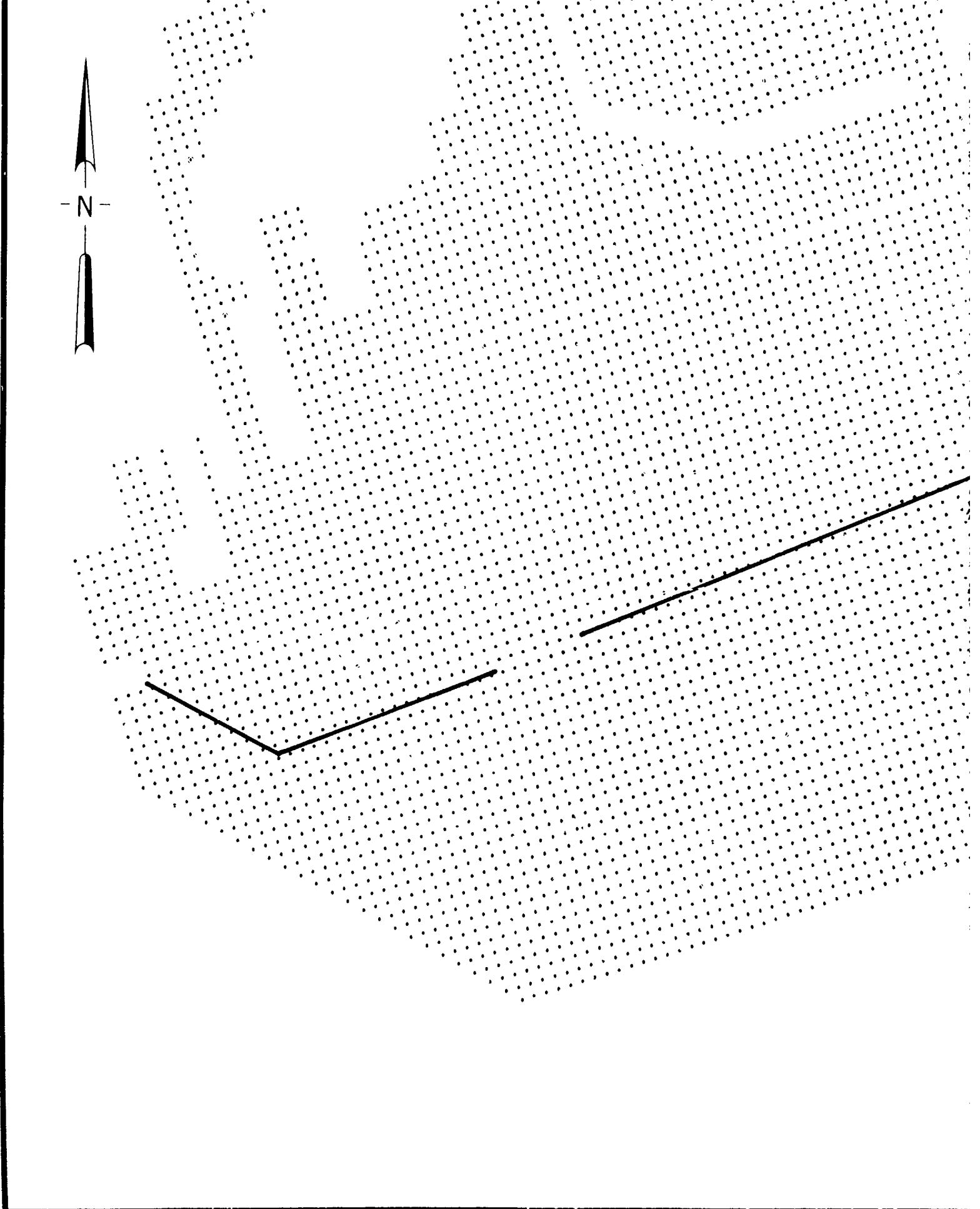
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PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,

82 FT CHANNEL 300 FT OPENING



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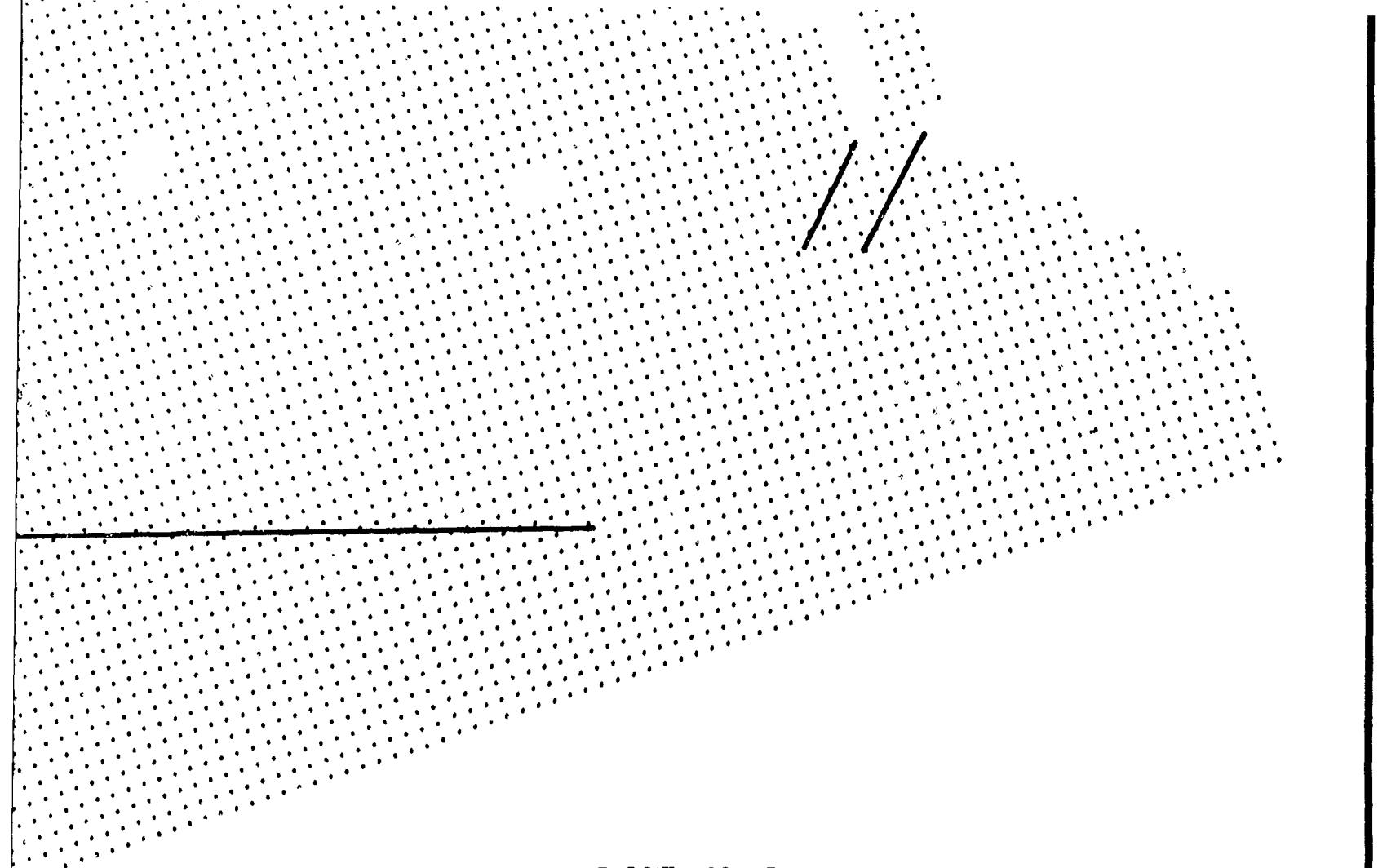
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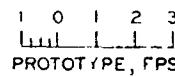
HOUR 1

SCALE IN FEET

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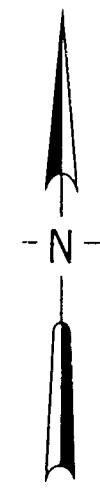
VELOCITY SCALE



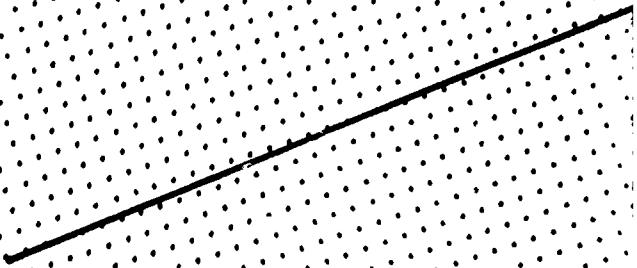
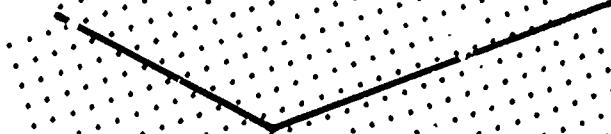
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN BETWEEN SCHEME STFP 2, -82-FT CHANNEL, 300-FT OPENING, AND EXISTING CONDITIONS

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)



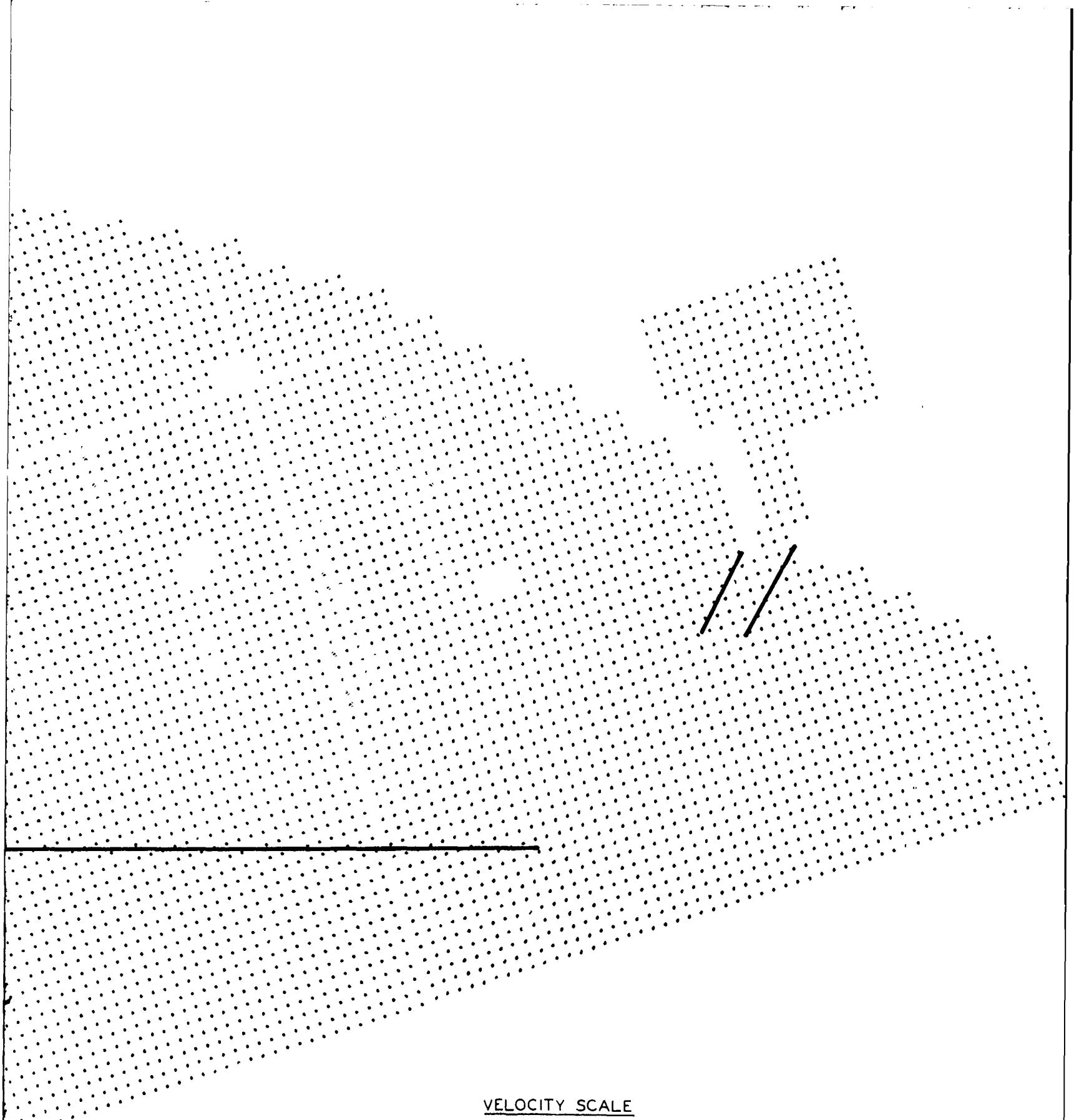
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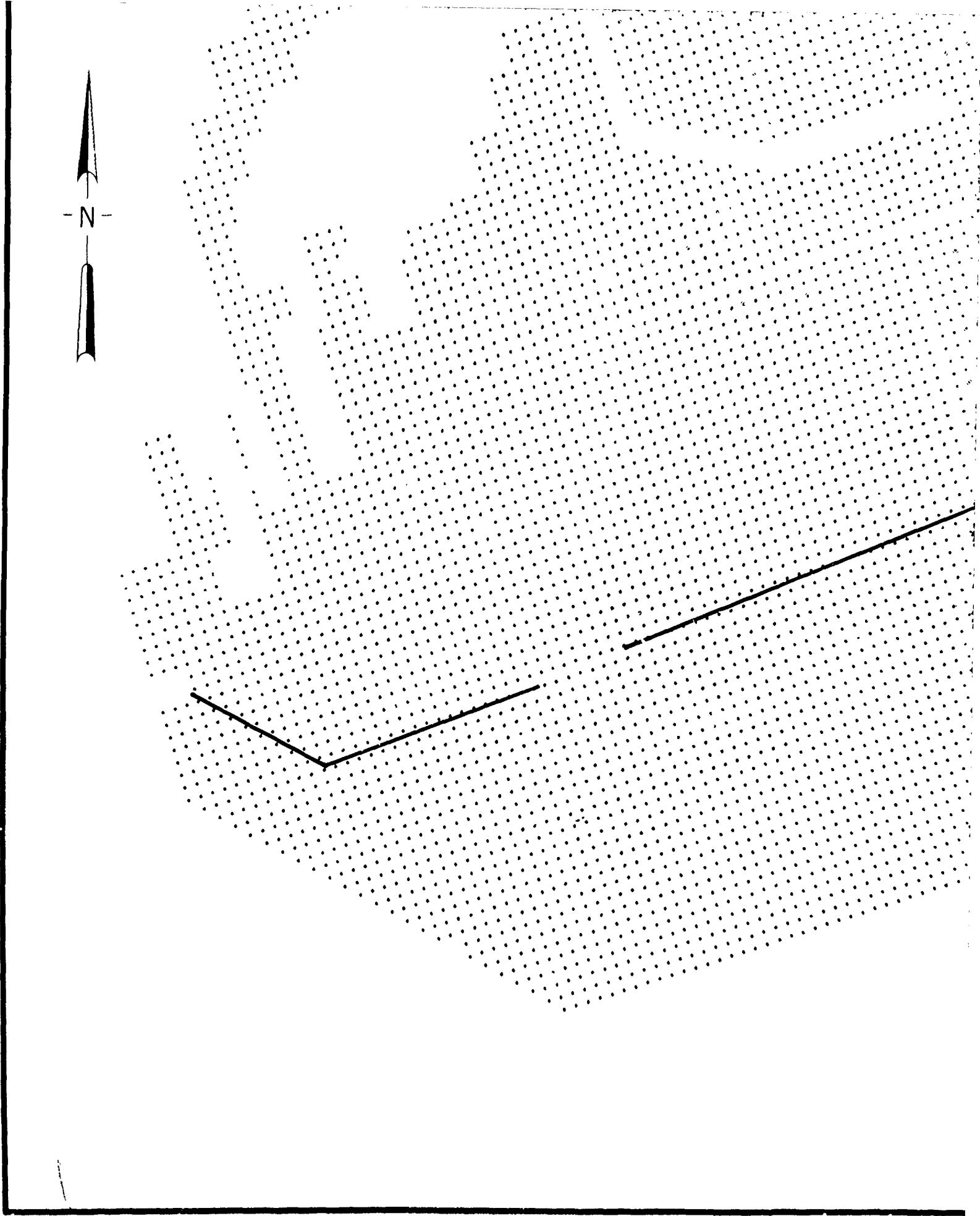


VELOCITY SCALE

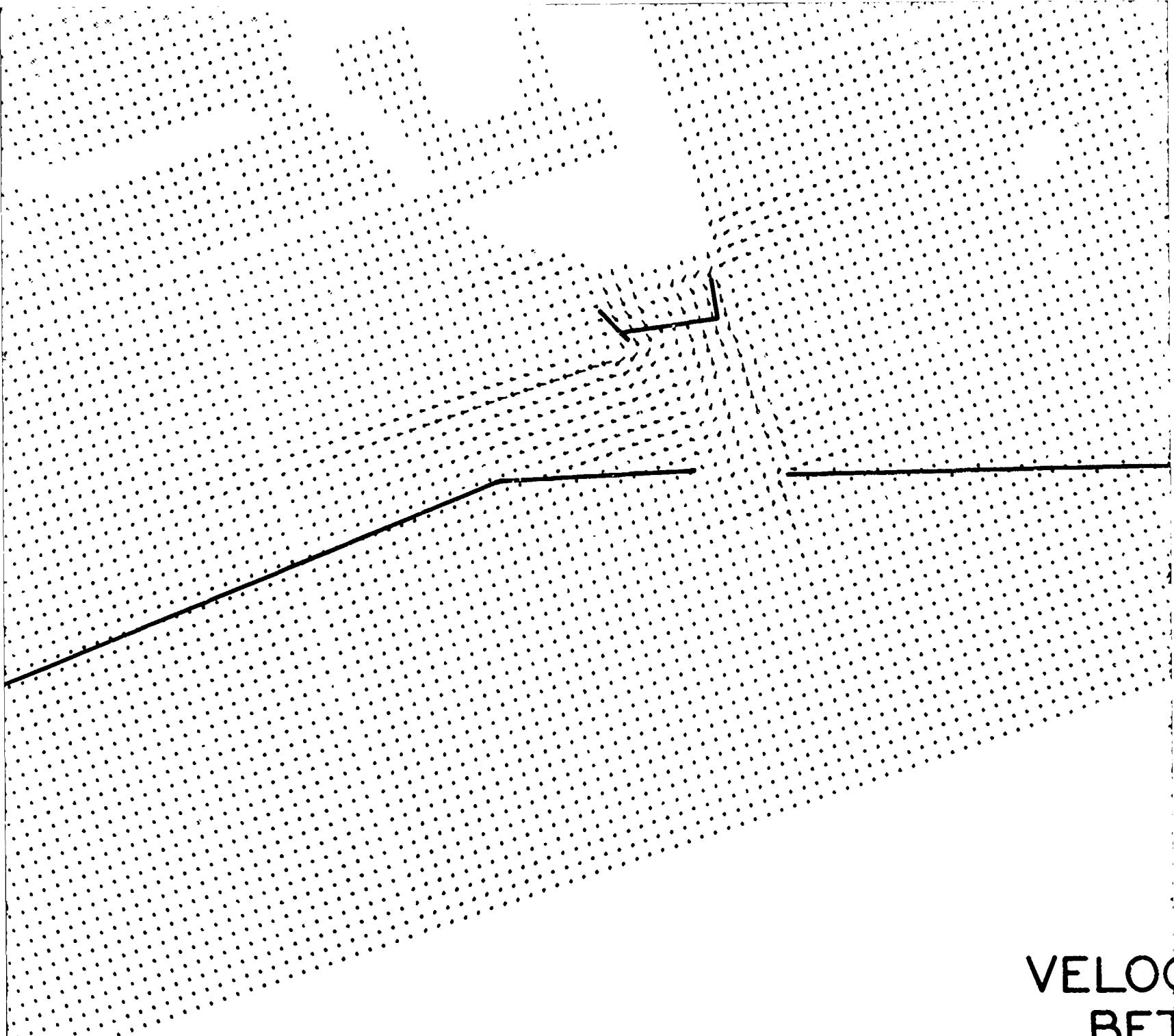
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PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,**



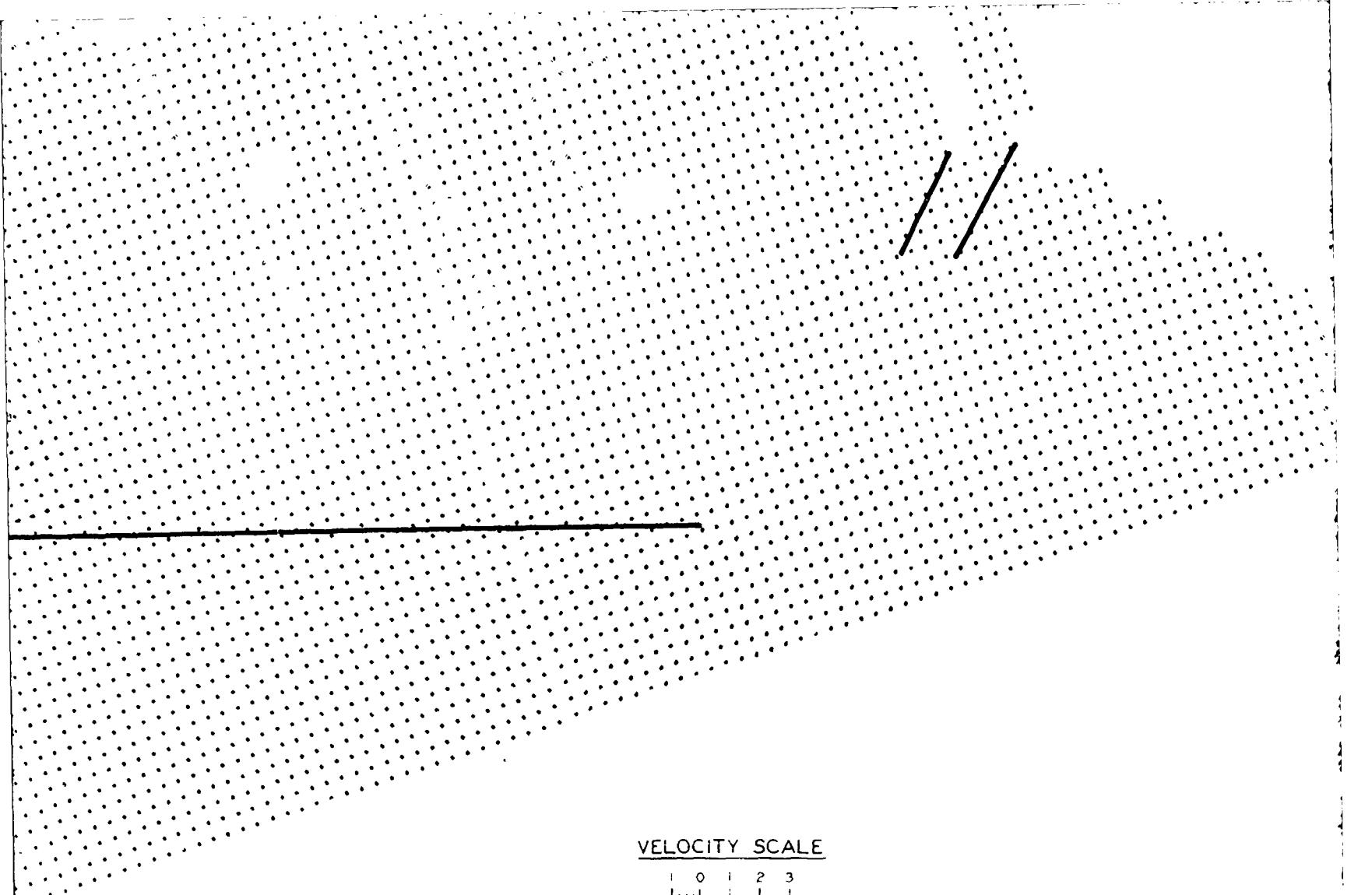
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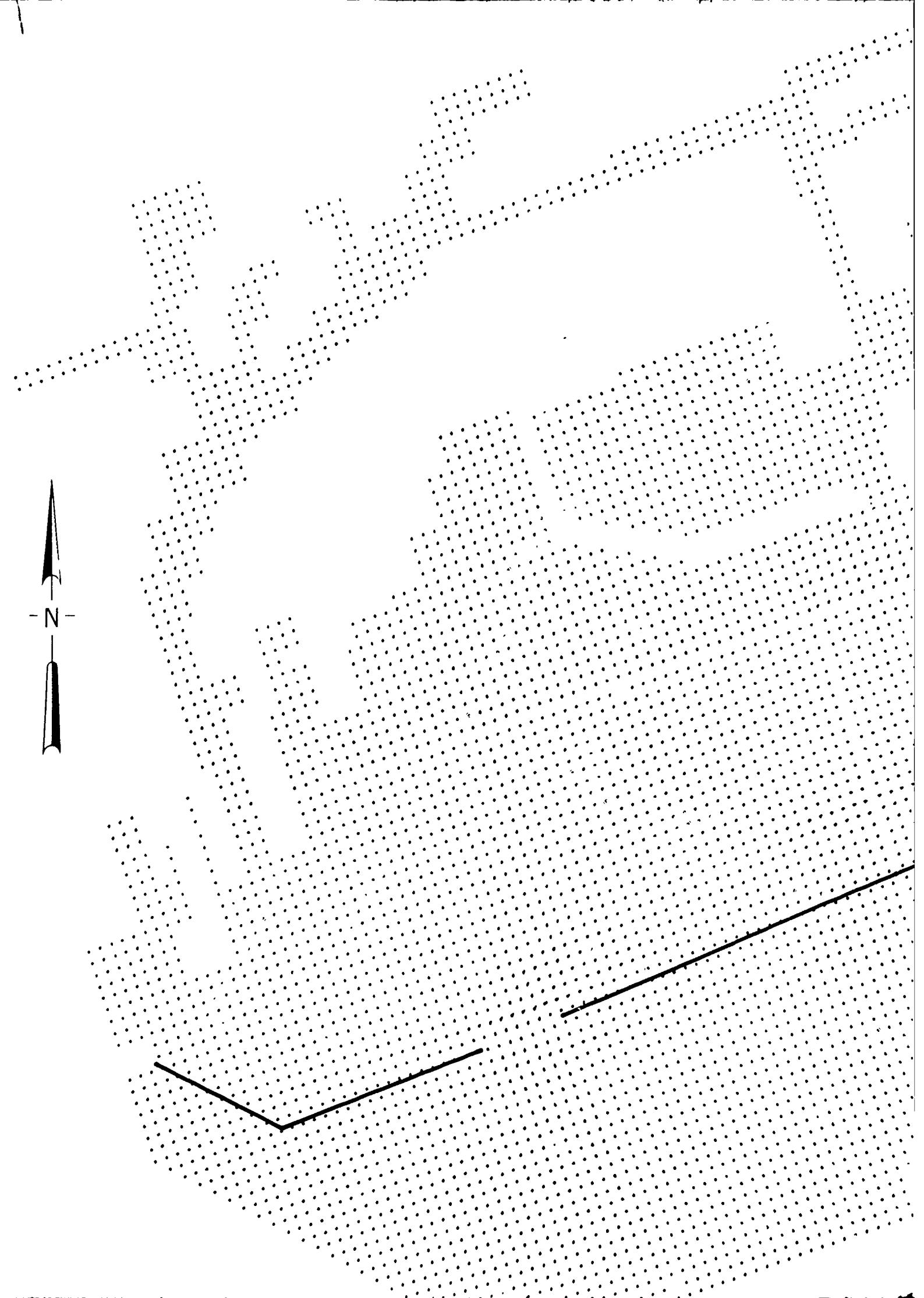
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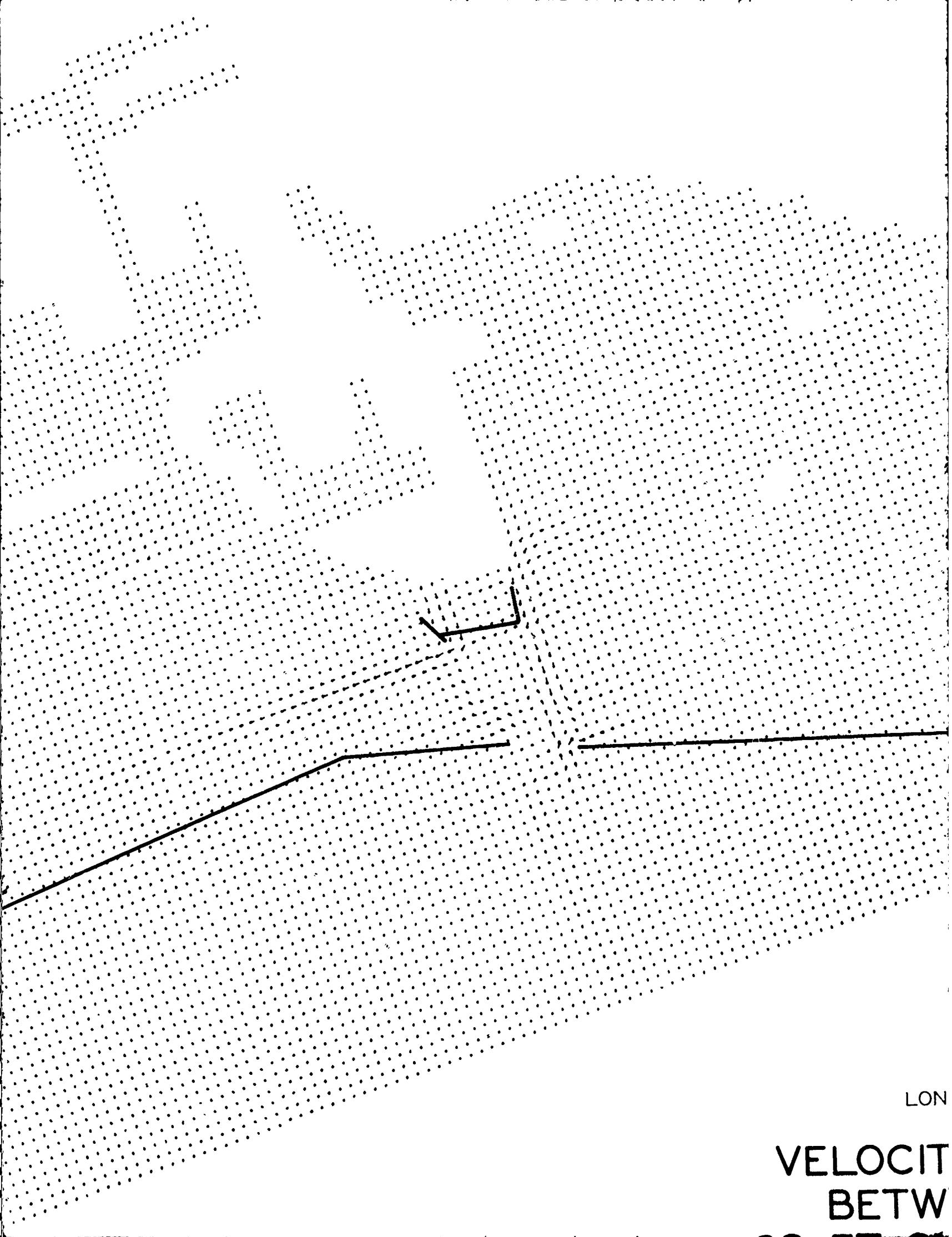
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 300-FT OPENING,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)





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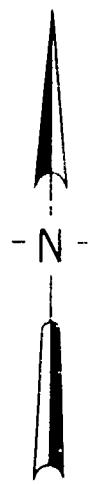
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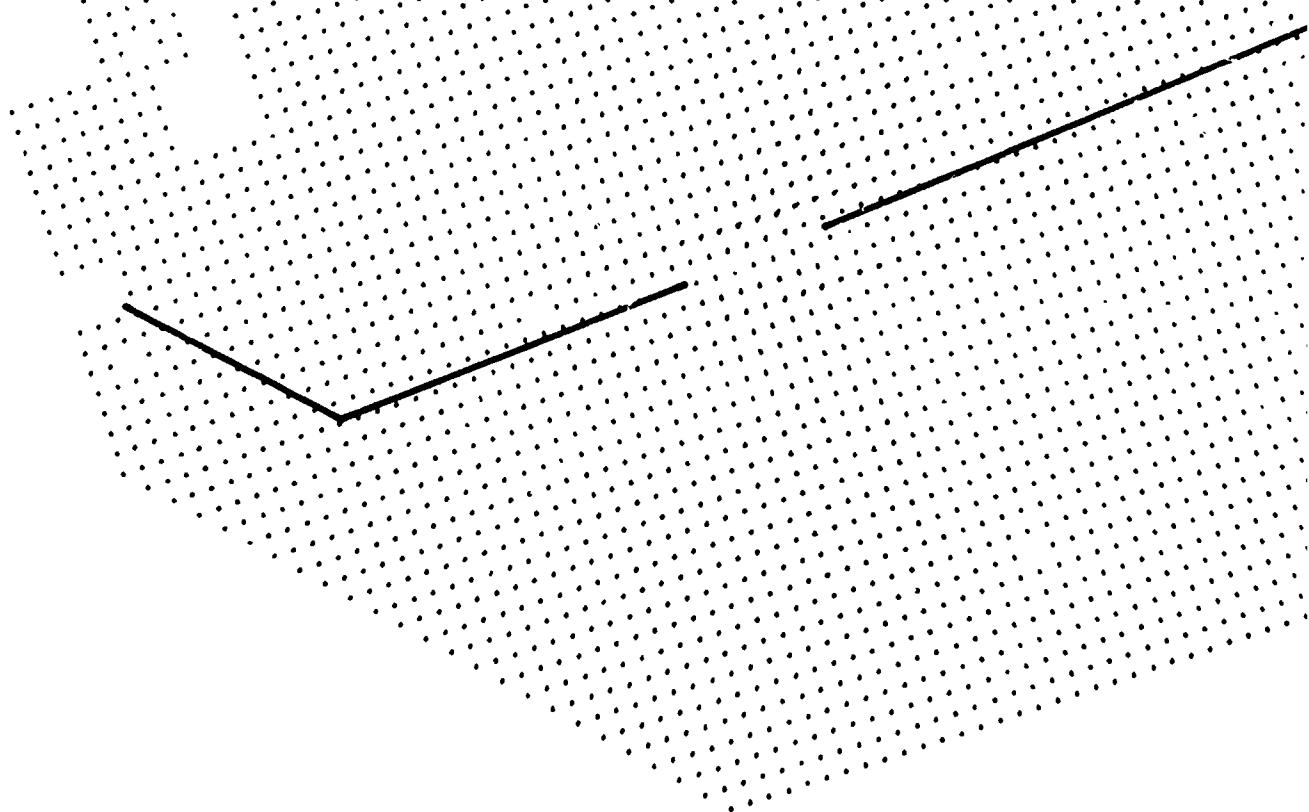
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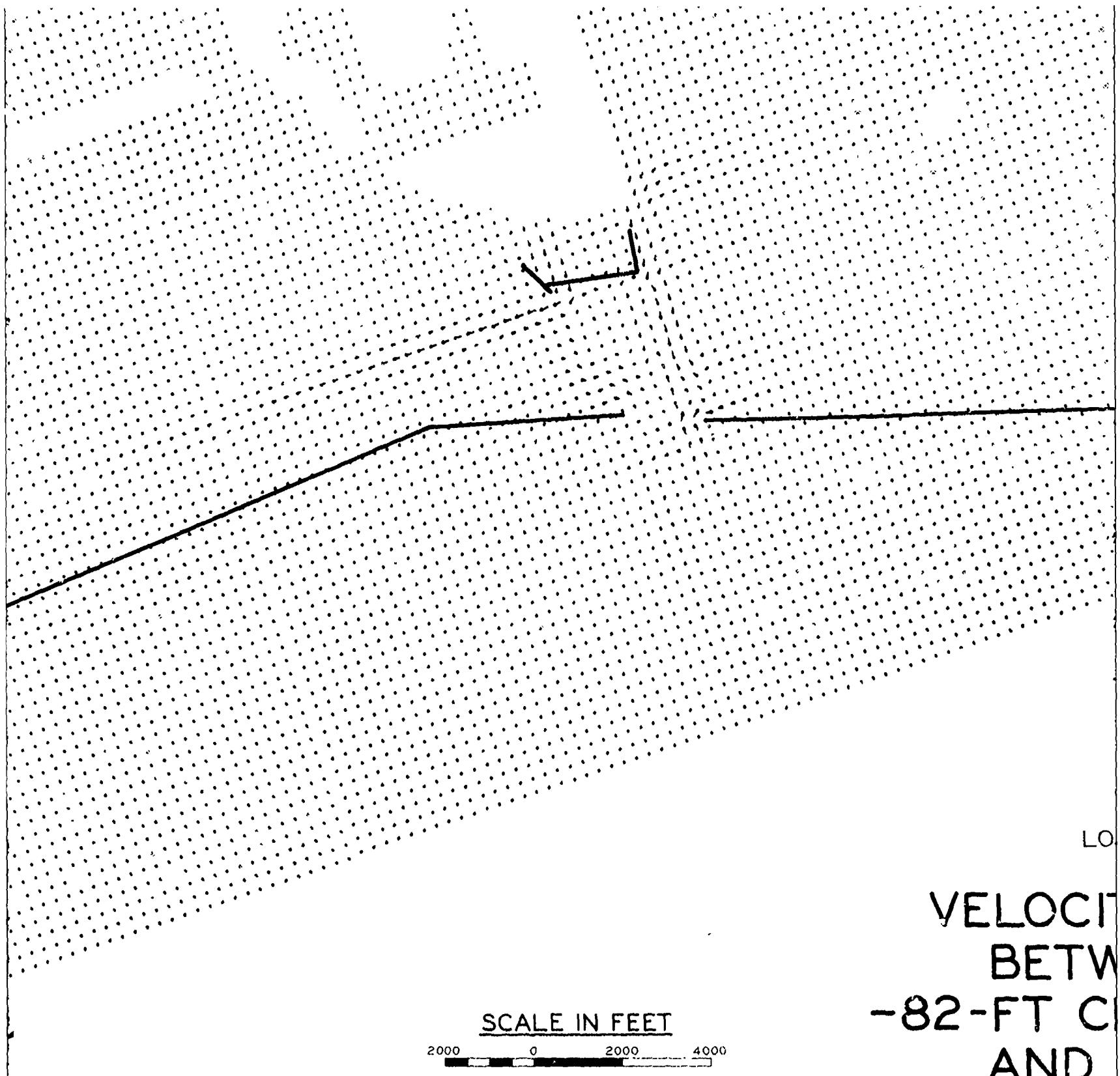
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
82-FT CHANNEL 200-FT OPENING



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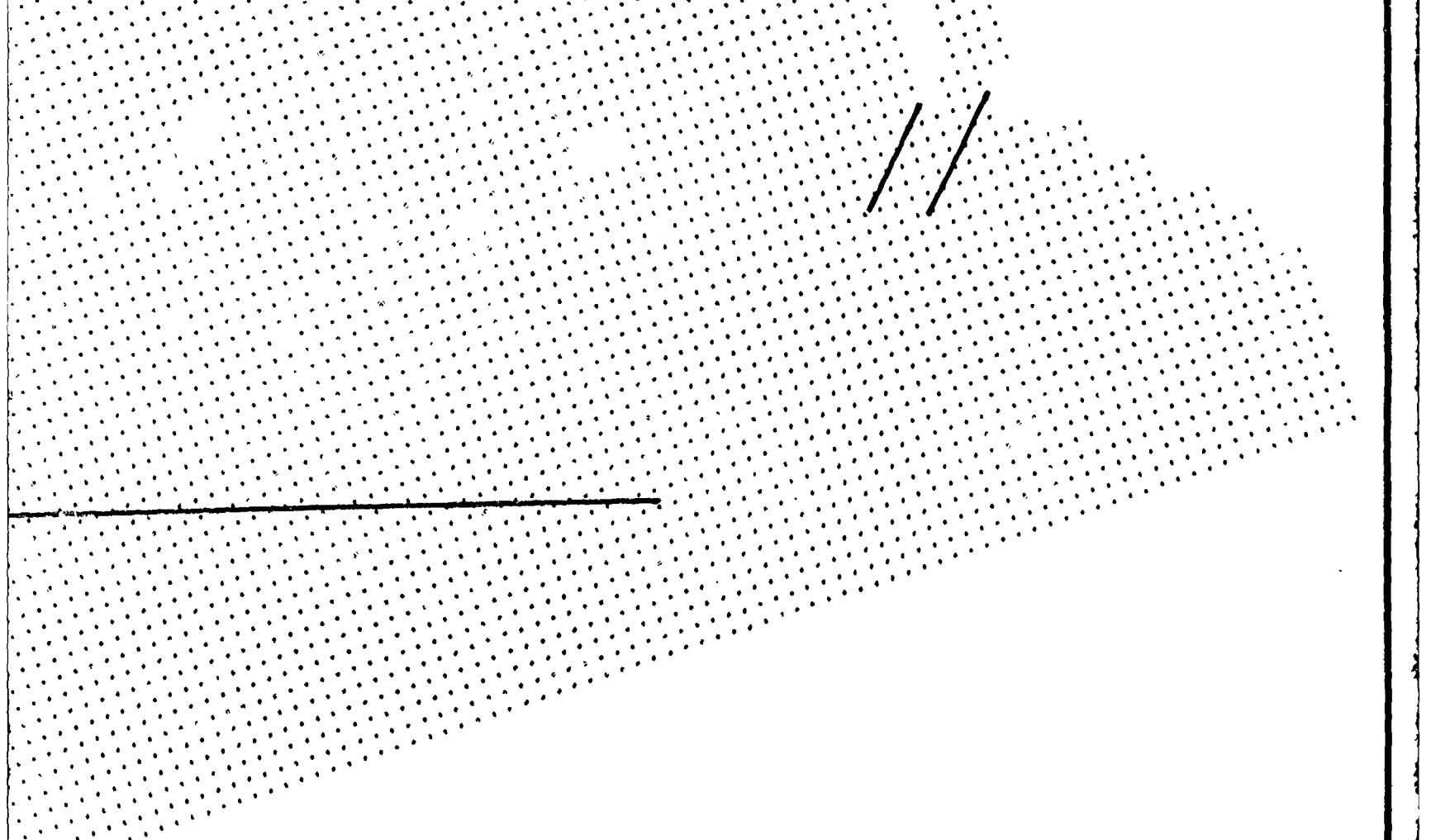




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VELOCITY SCALE

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PROTOTYPE, FPS

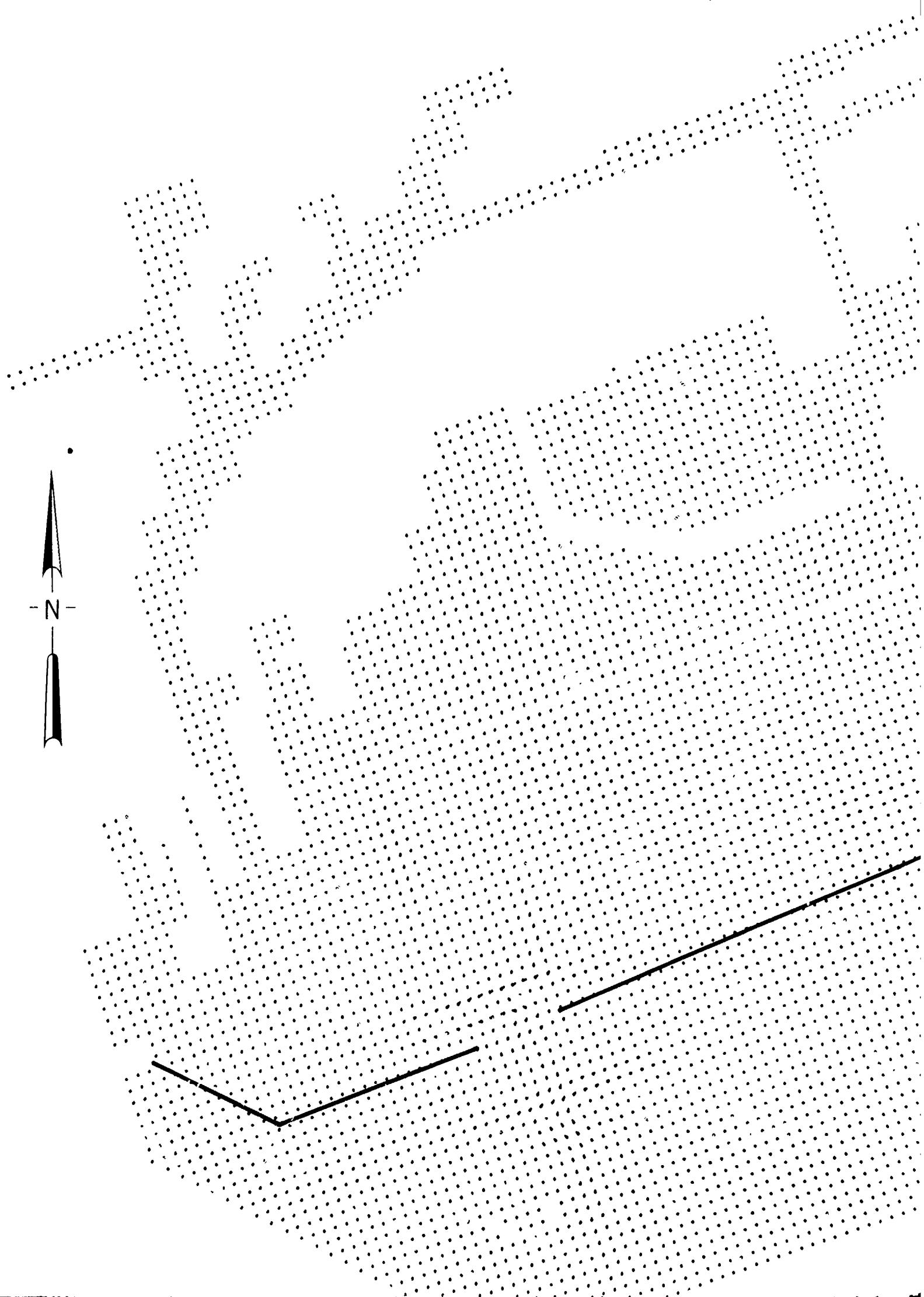
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

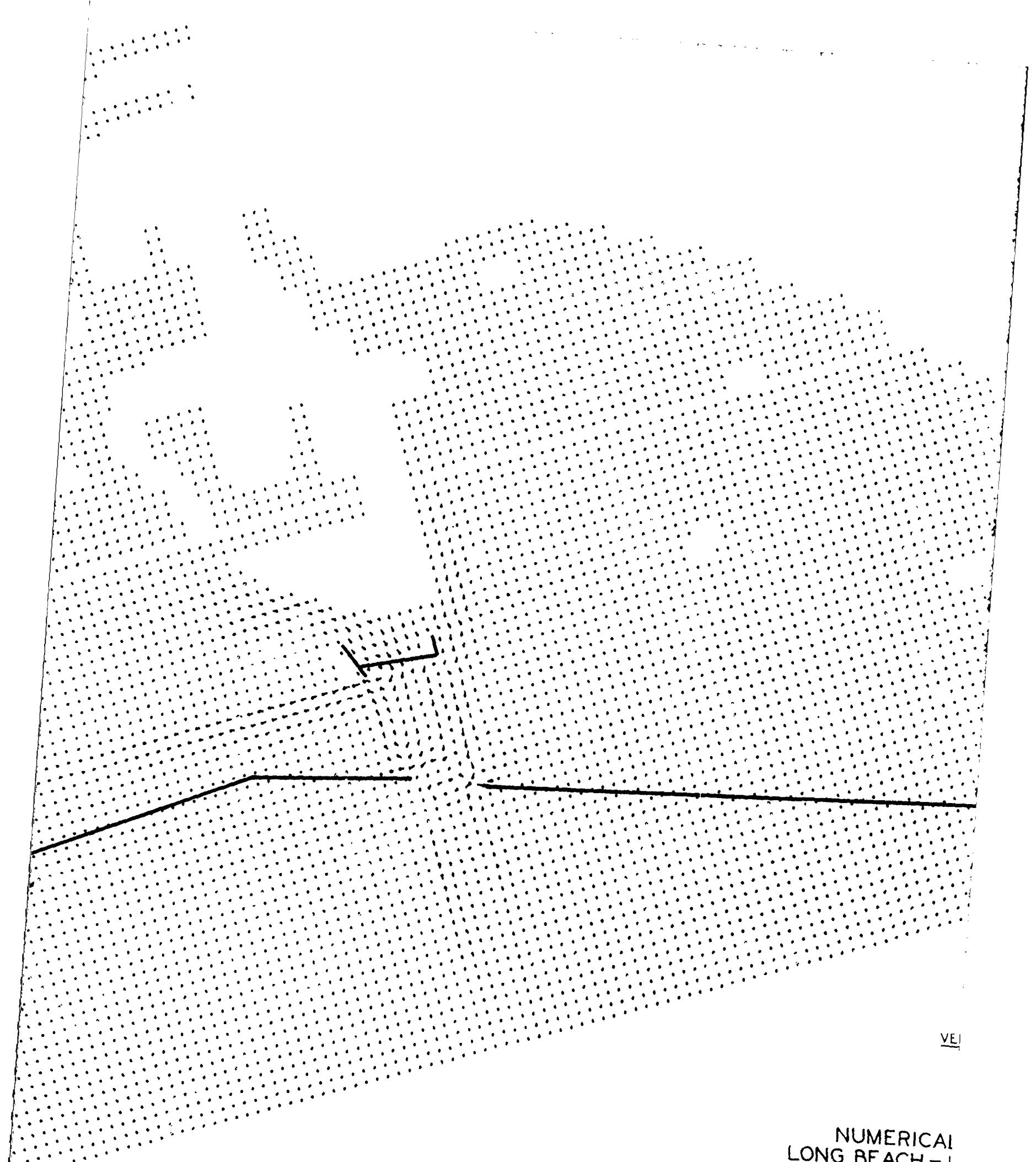
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 300-FT OPENING,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)

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FIGURE 28

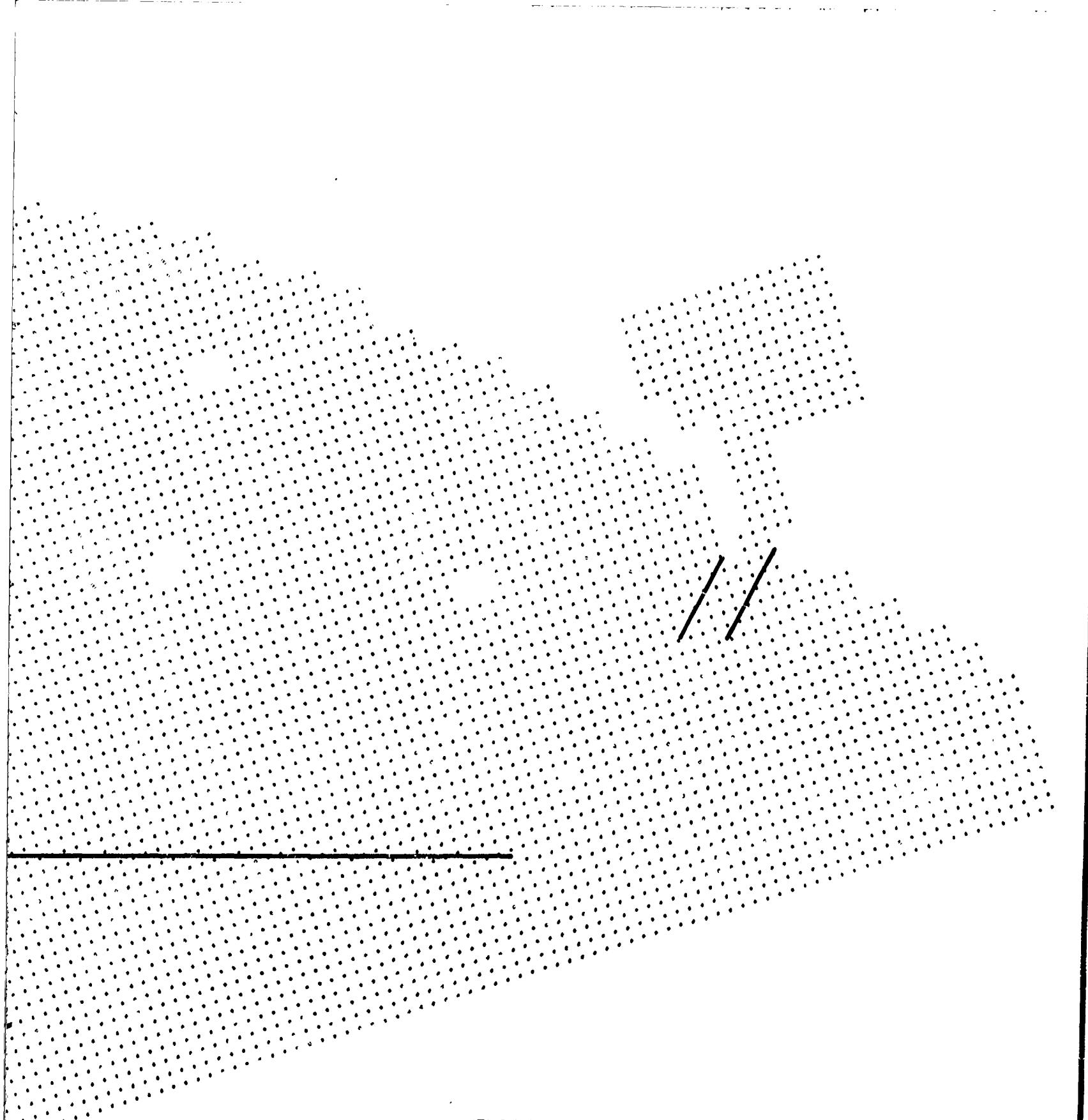




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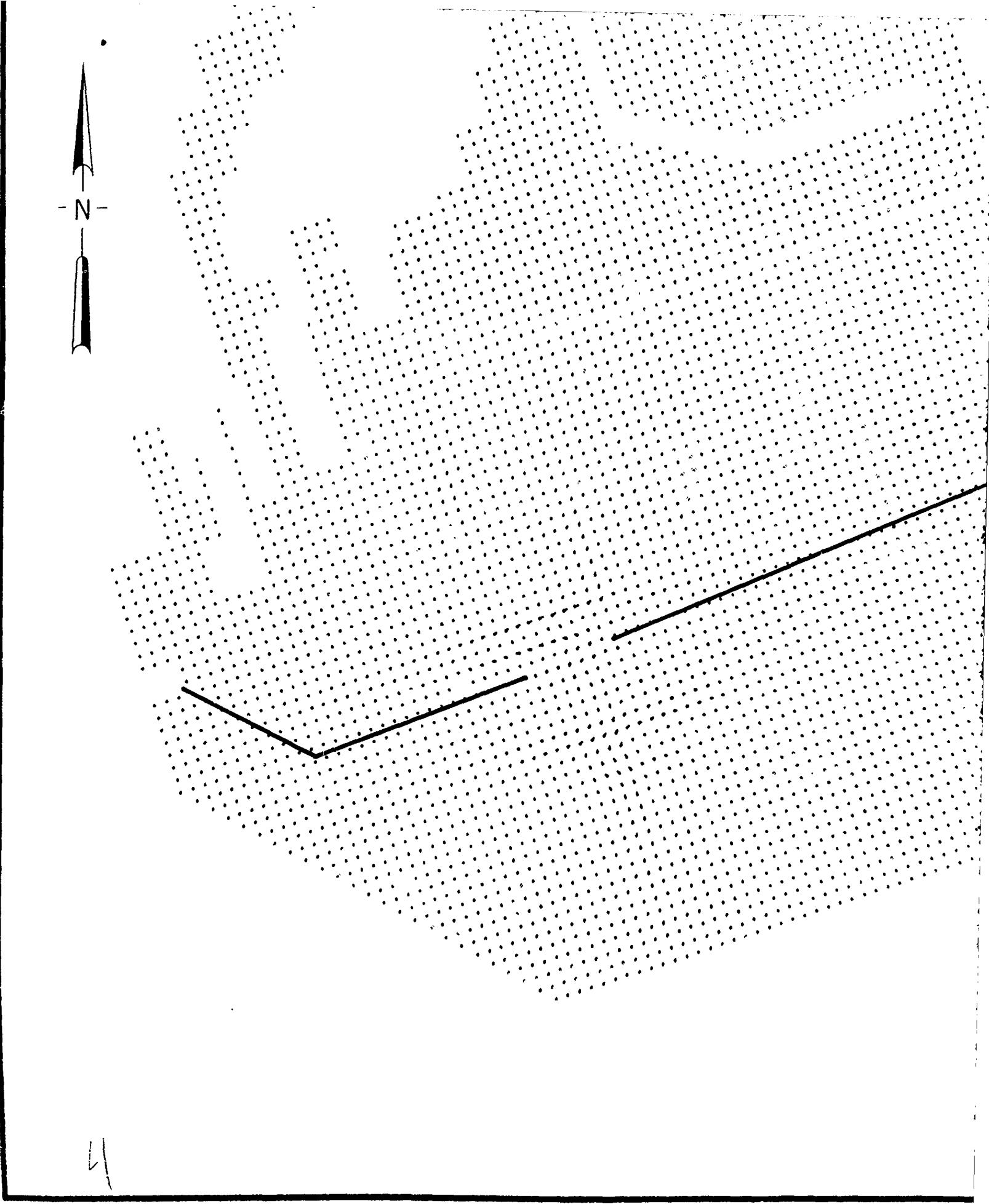
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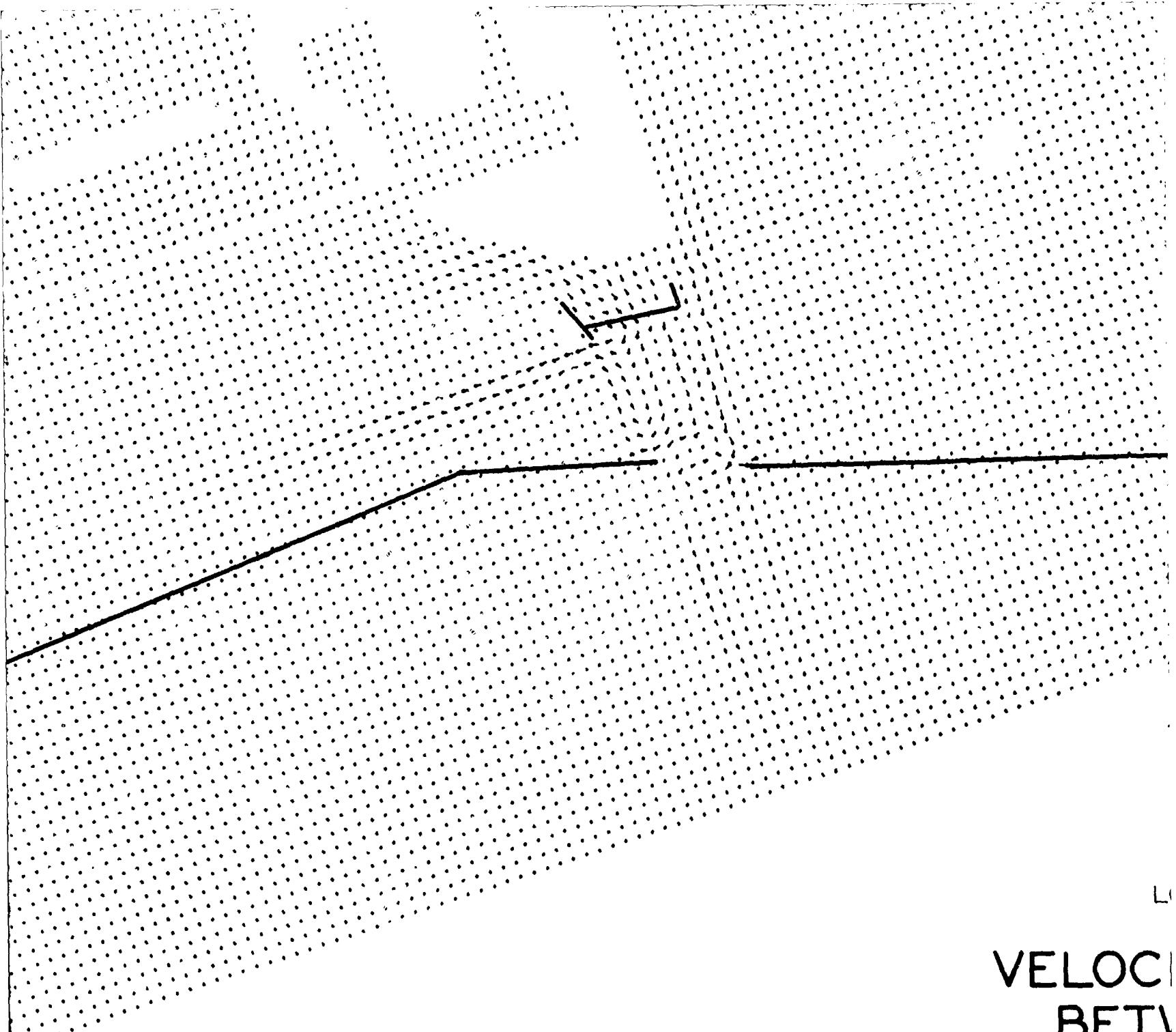


VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

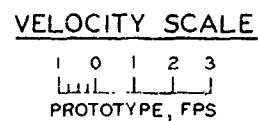
VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
00 FT CHANNEL





SCALE IN FEET
2000 0 2000 4000

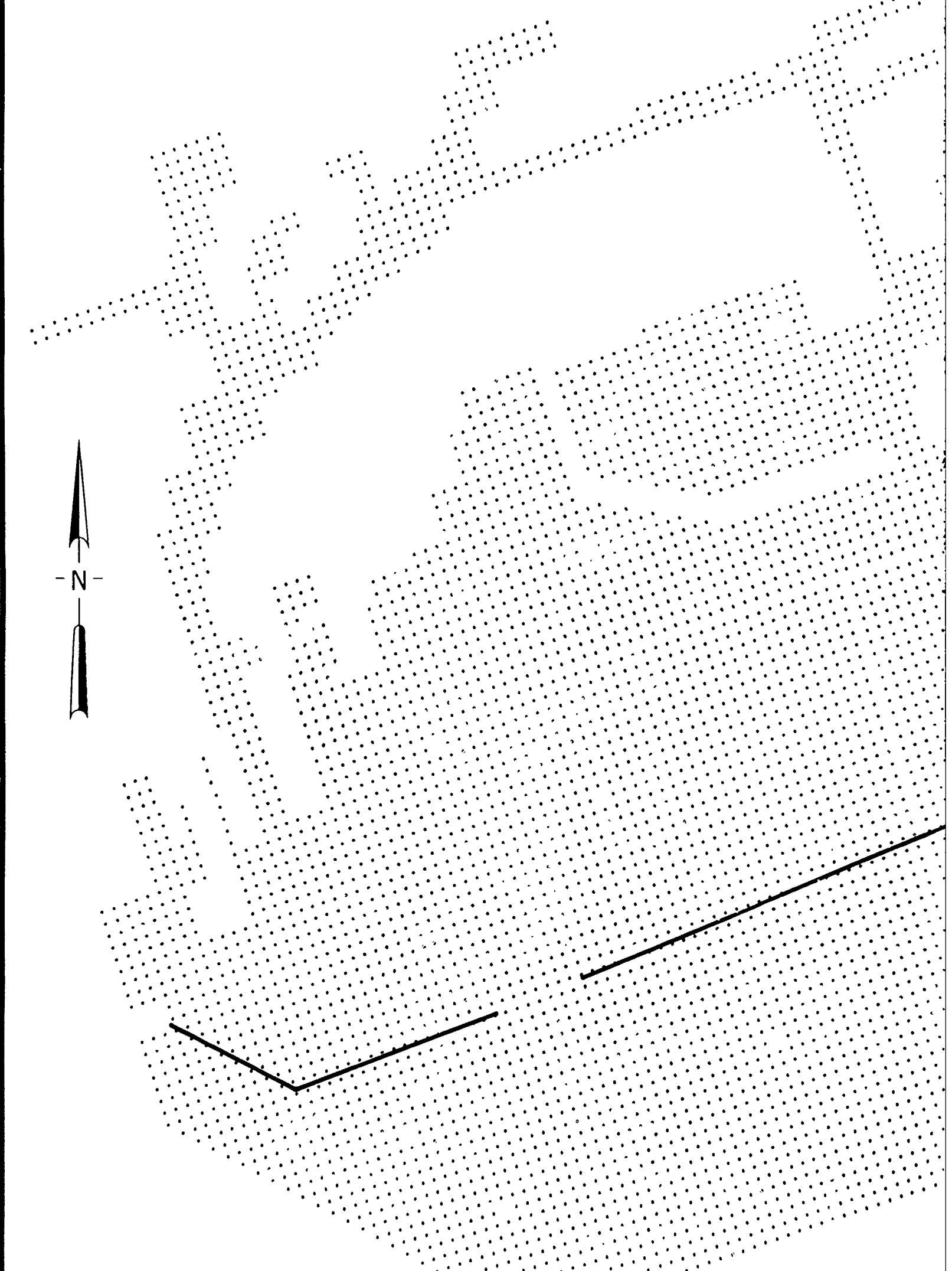
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

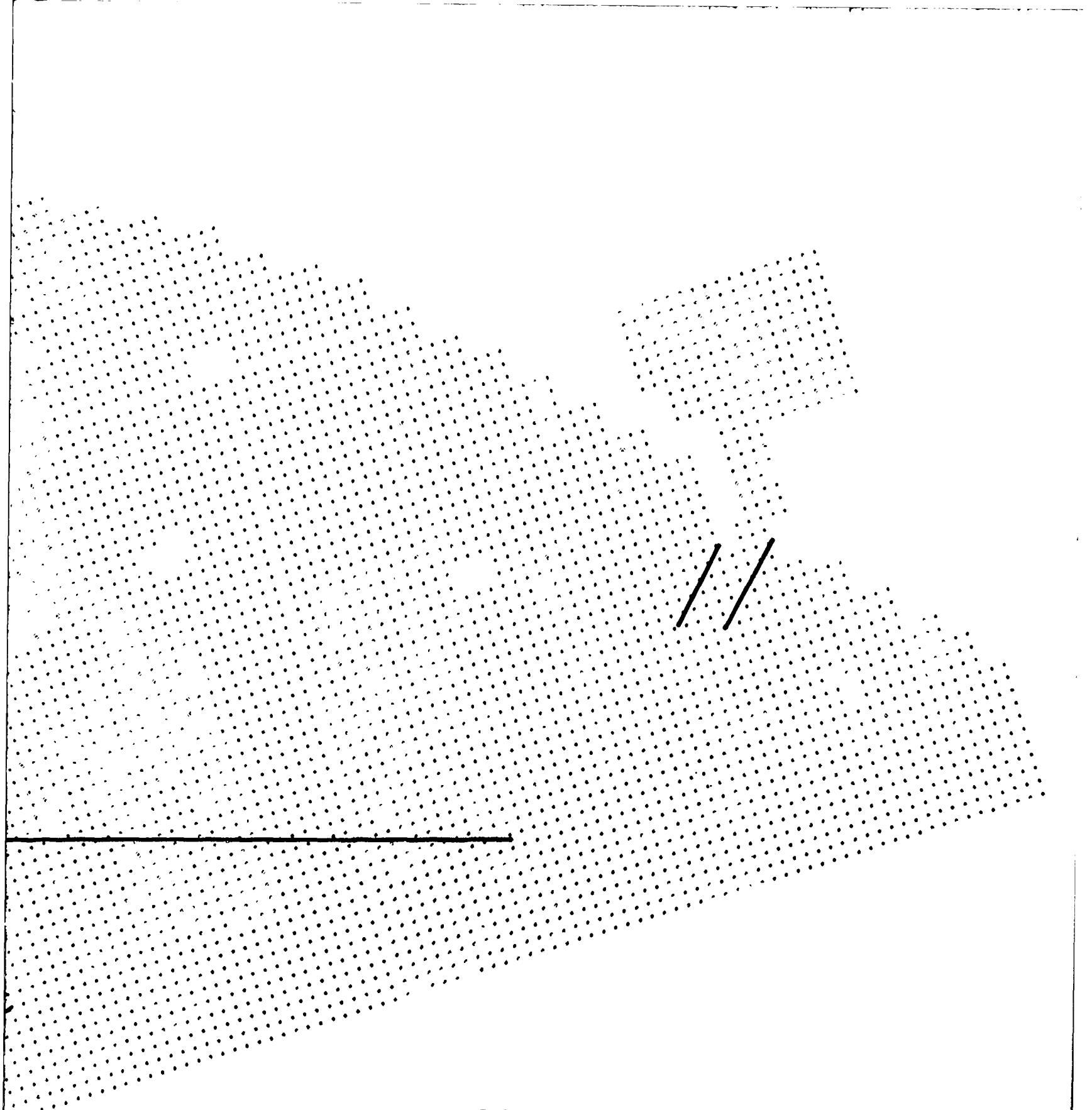
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 600-FT OPENING,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)



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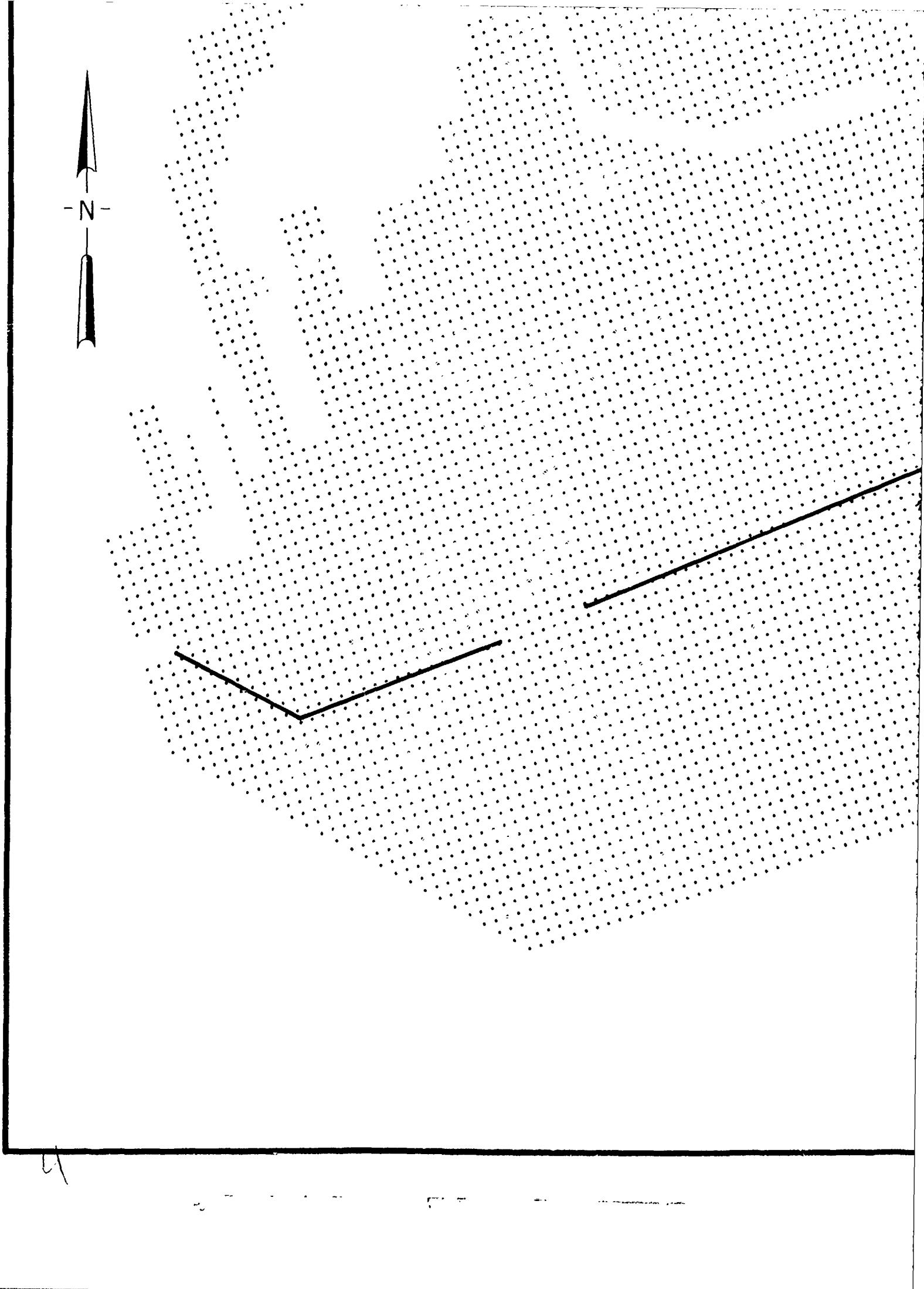


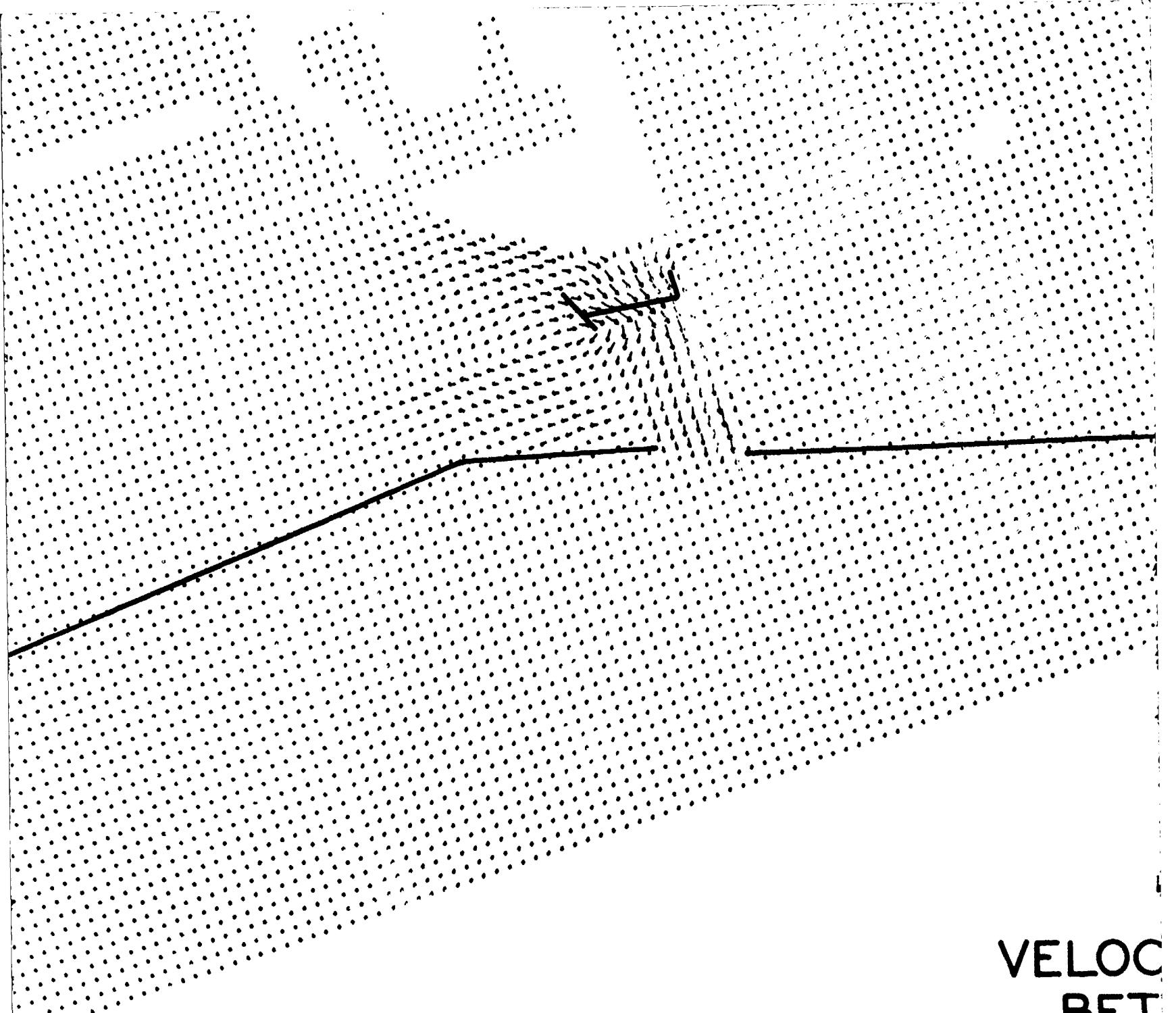
VELOCITY SCALE

1 0 1 2 3
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PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STEP 2





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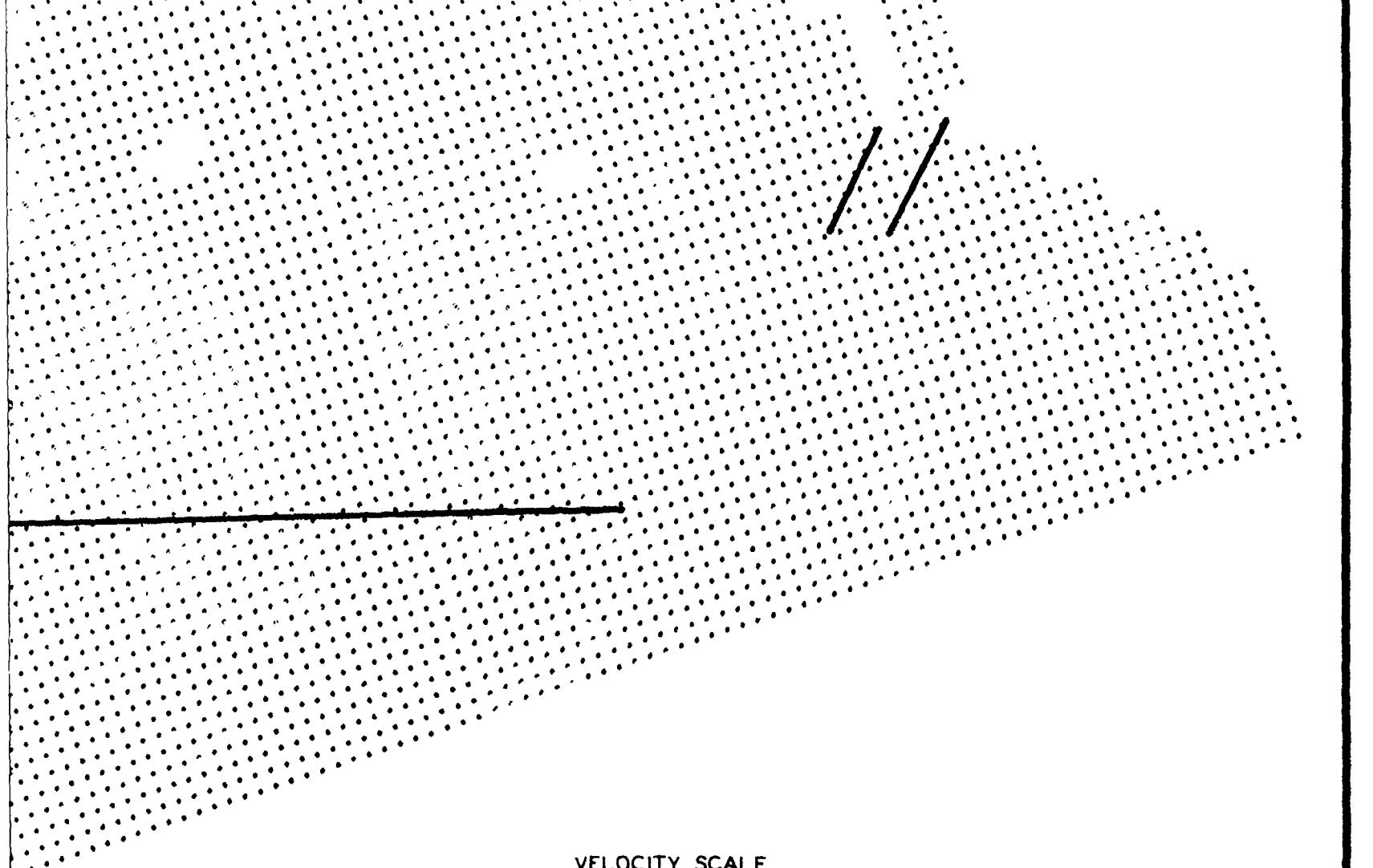
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AND

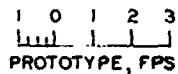
SCALE IN FEET

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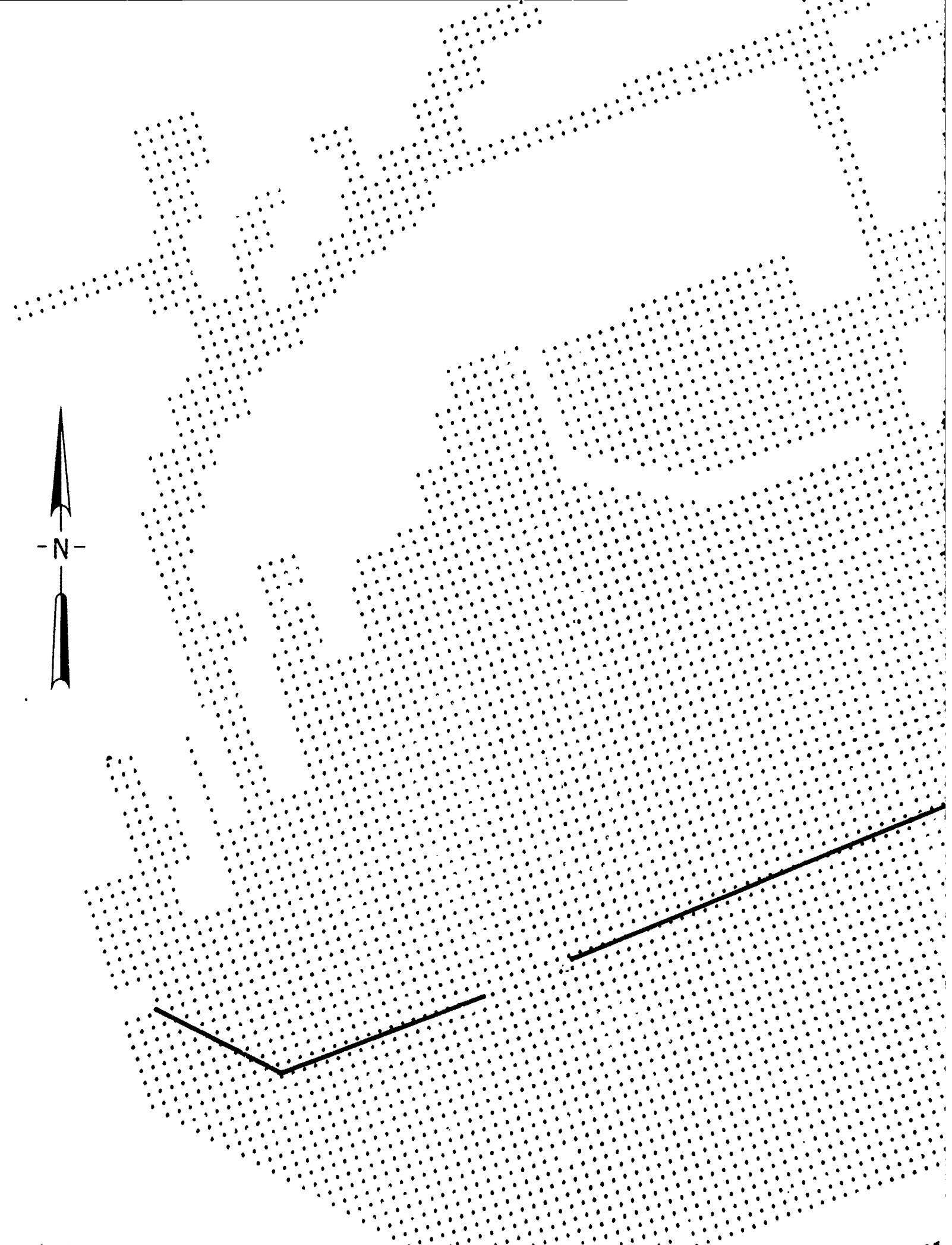
VELOCITY SCALE

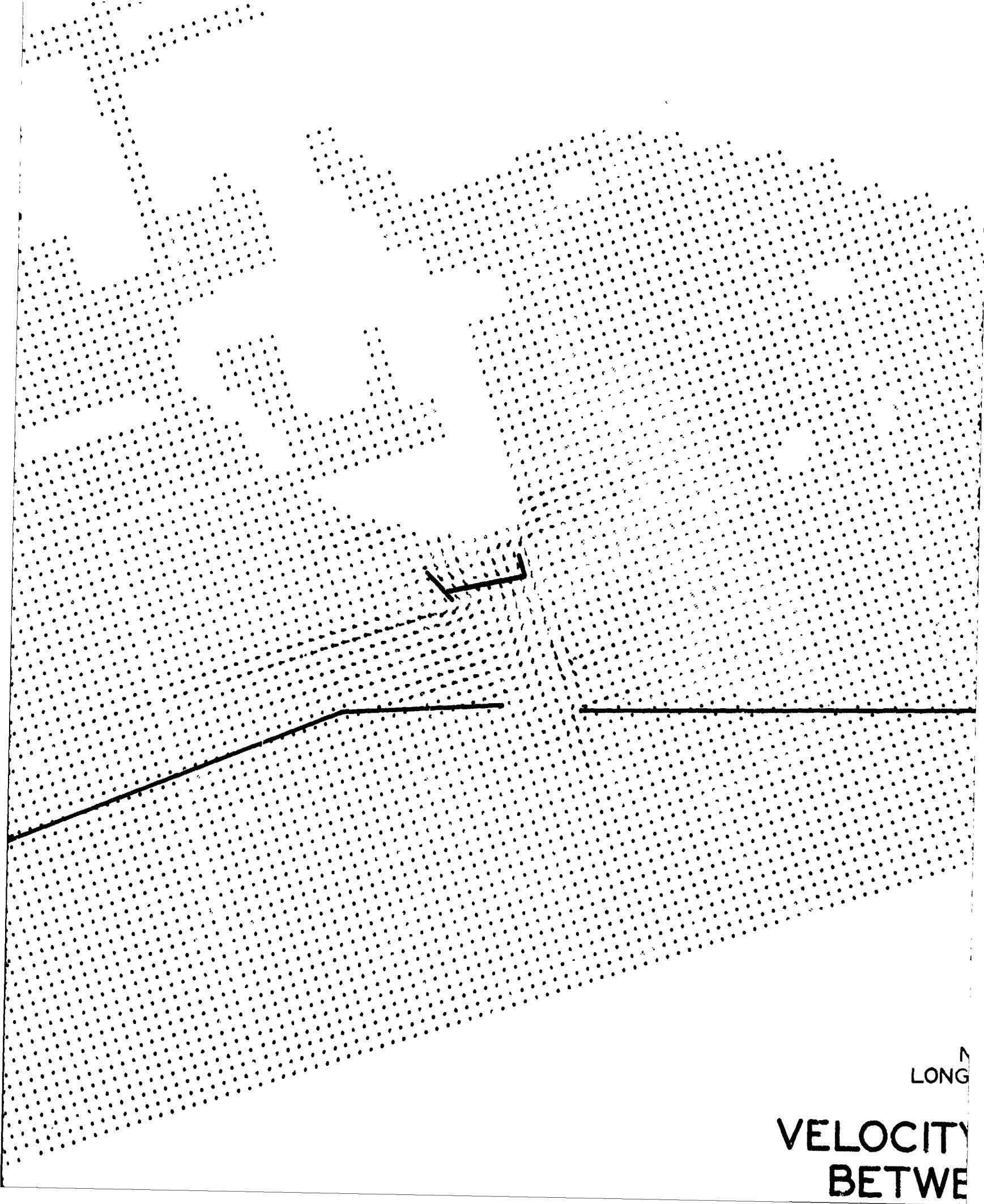


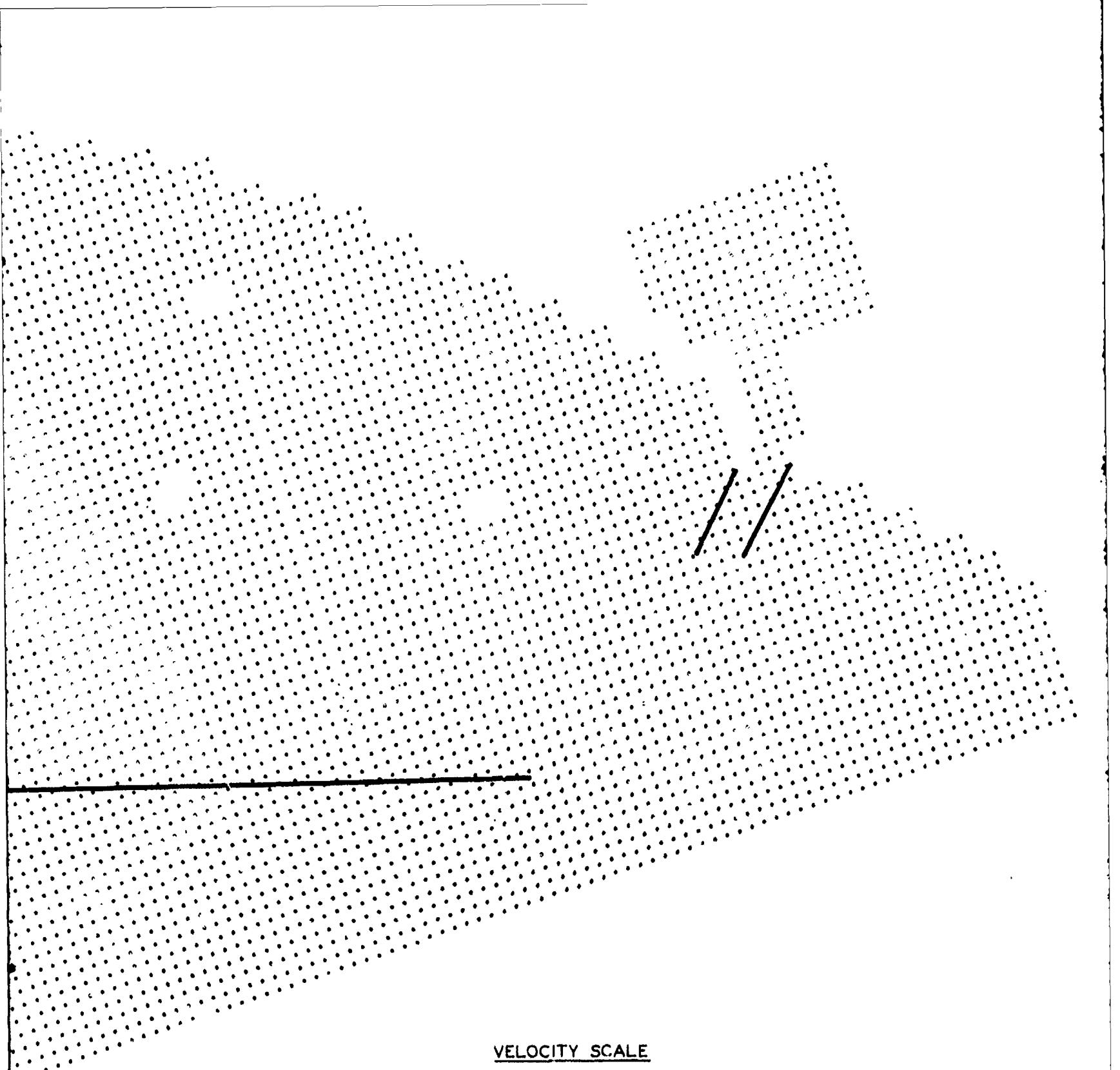
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 600-FT OPENING,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)







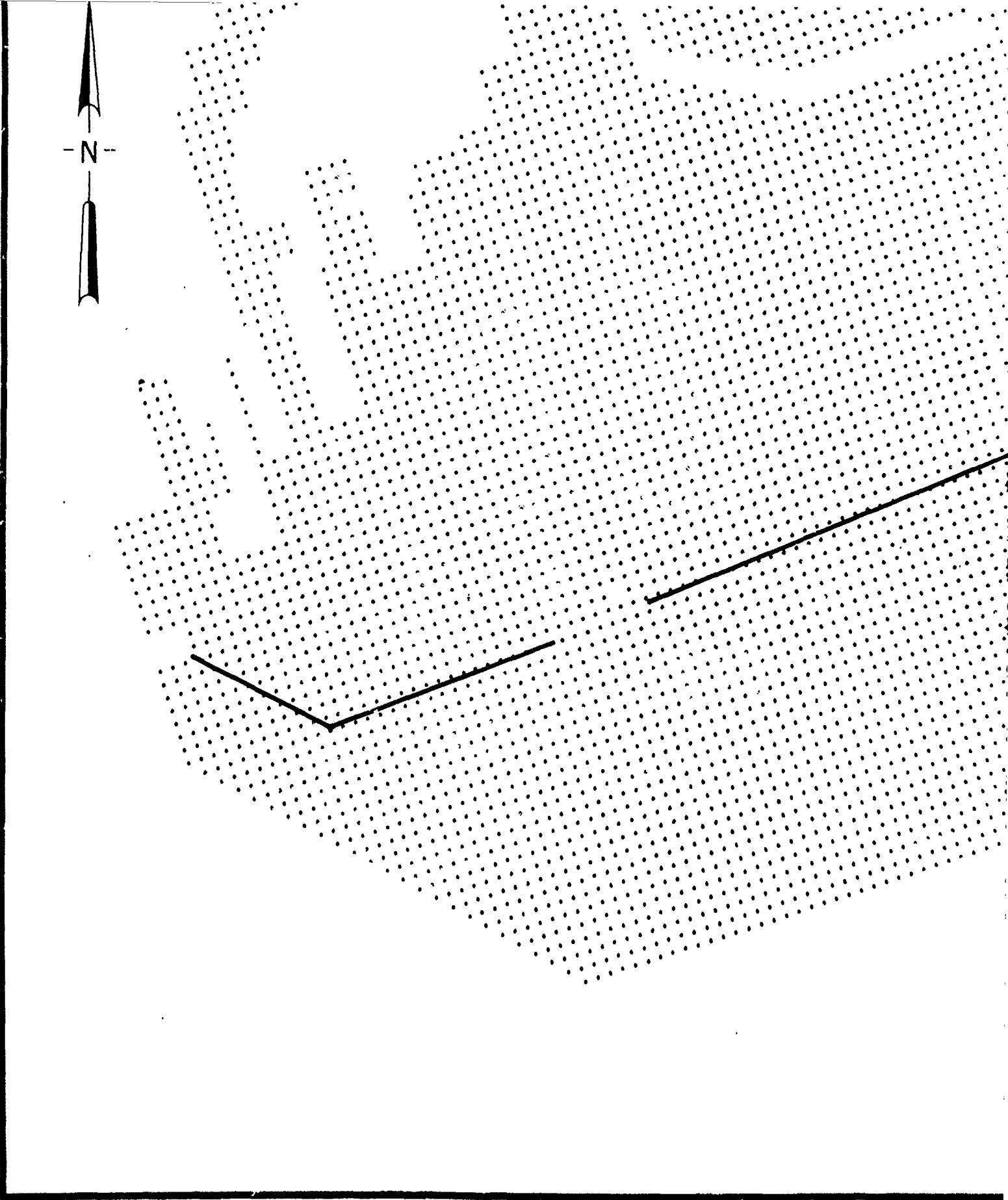
VELOCITY SCALE

1	0	1	2	3

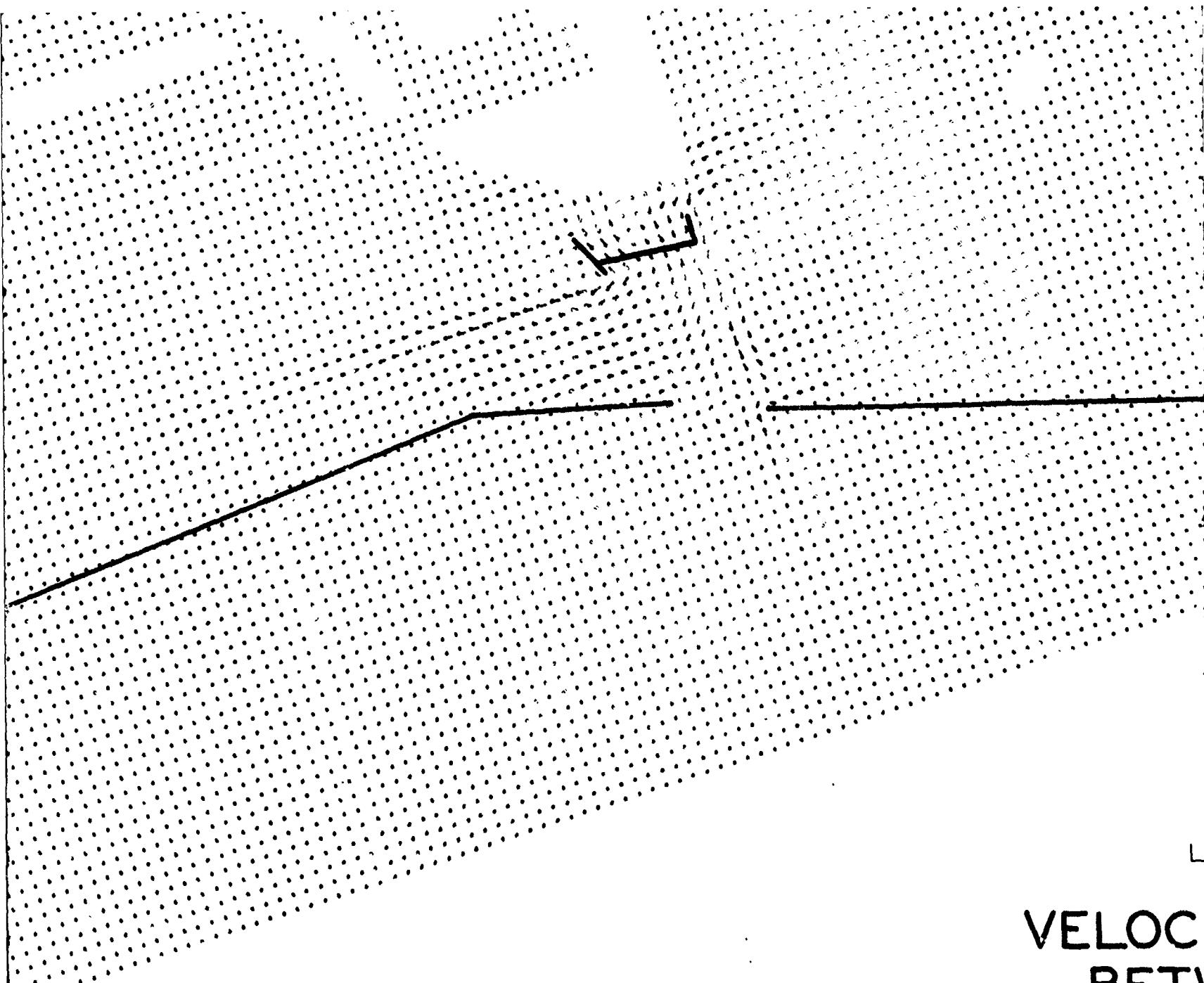
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,



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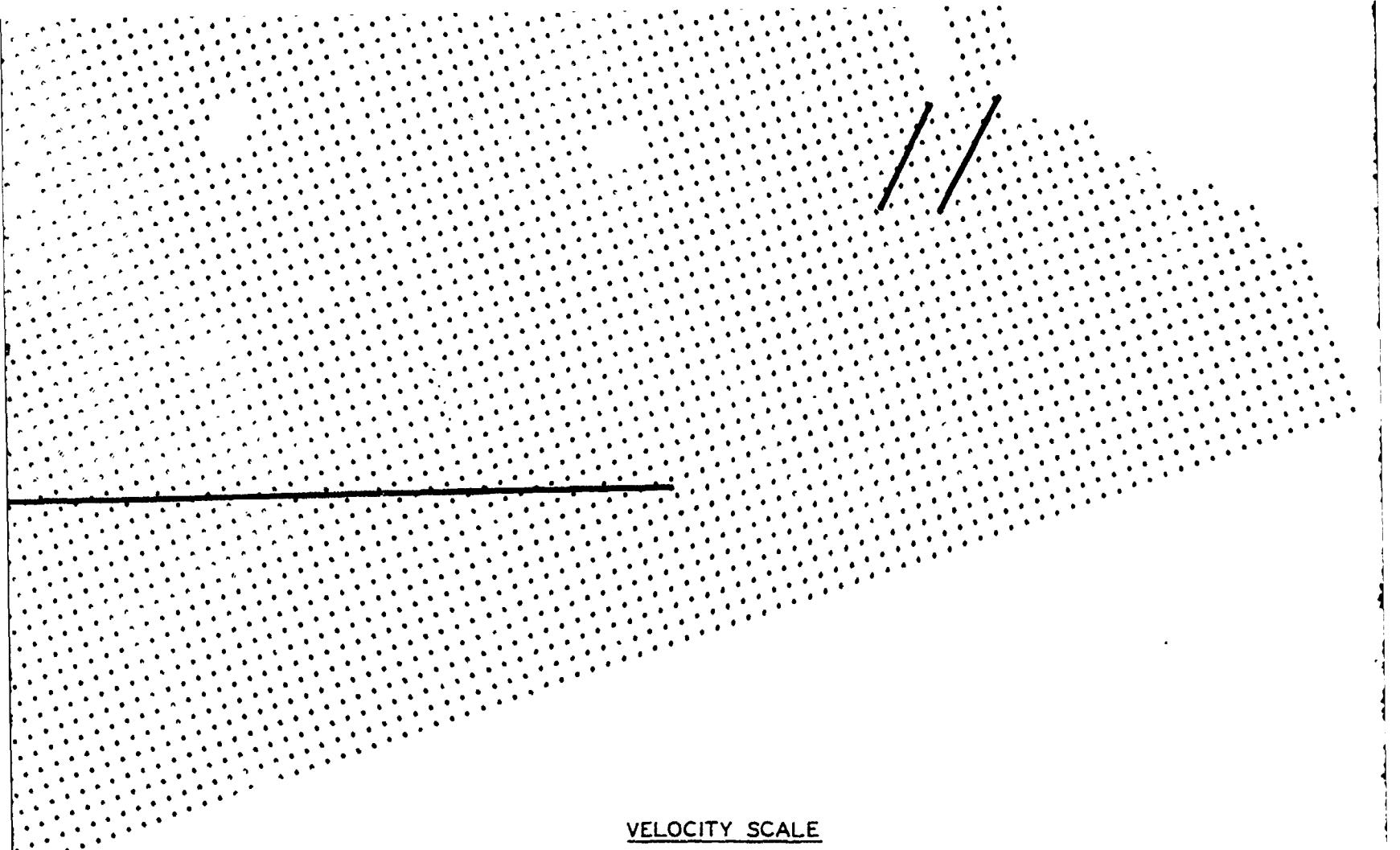
-82-FT C

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SCALE IN FEET

2000 0 2000 4000

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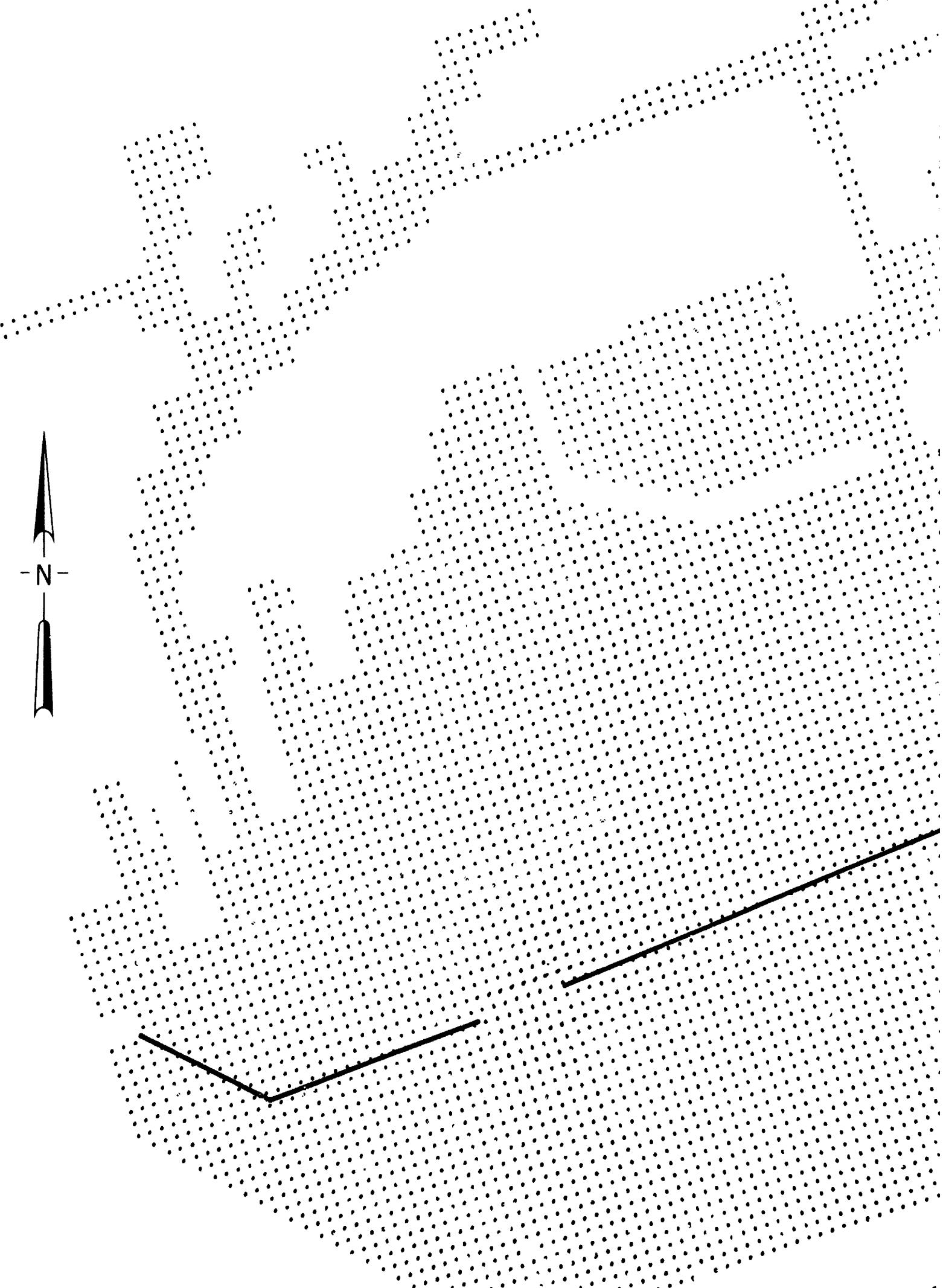
VELOCITY SCALE

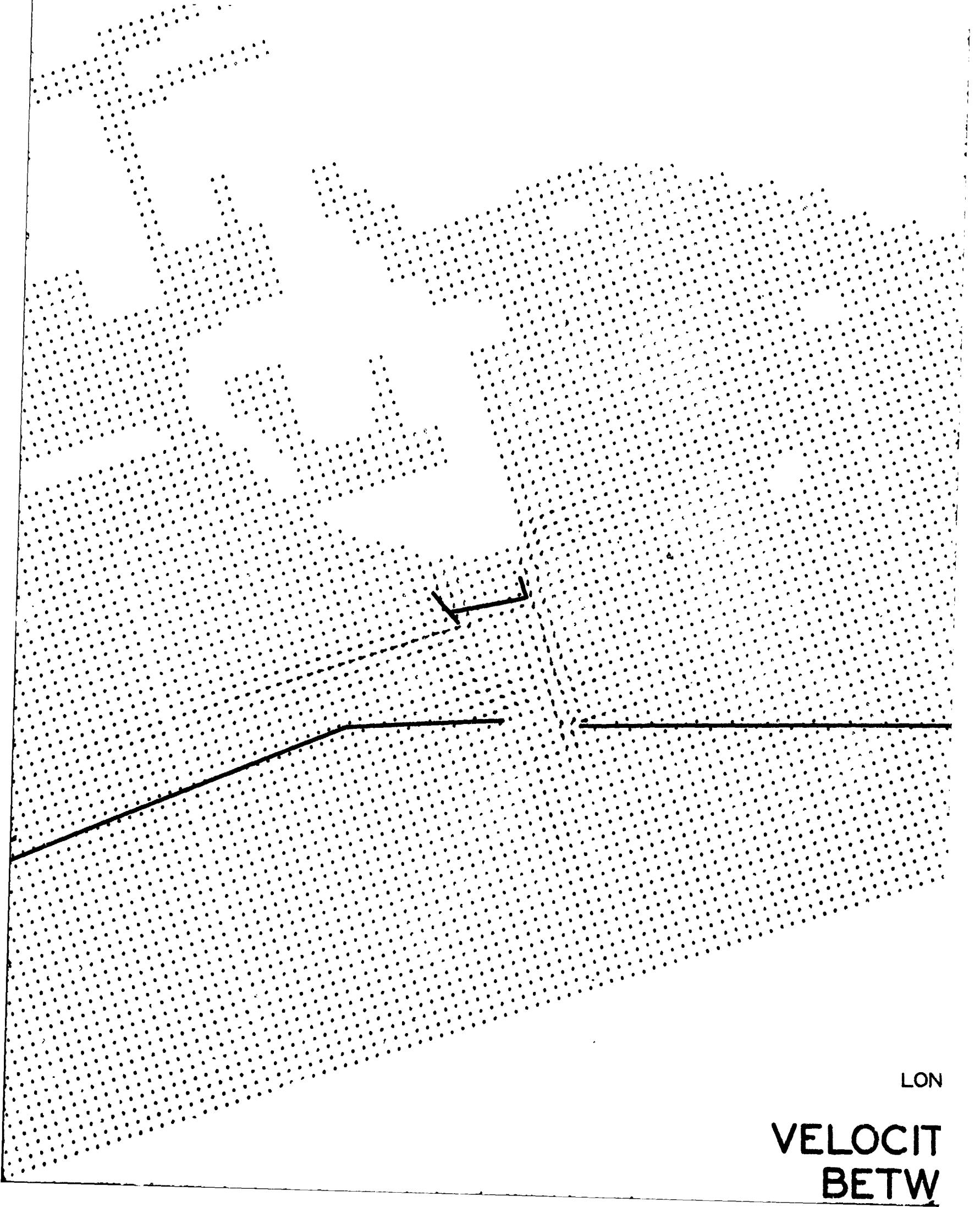


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 600-FT OPENING,
AND EXISTING CONDITIONS**

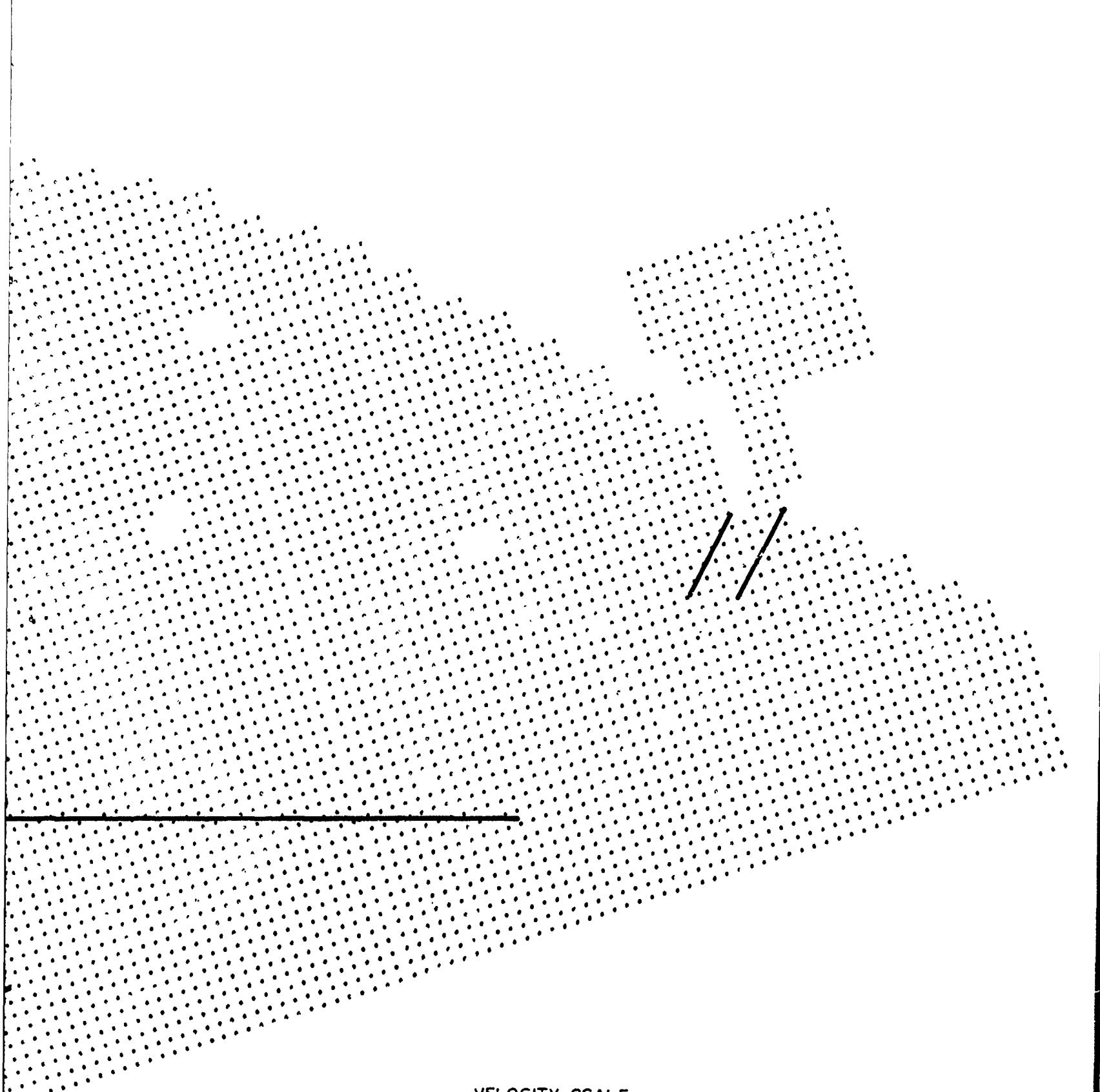
SPRING TIDE
HOUR 22 (NEAR SLACK WATER)





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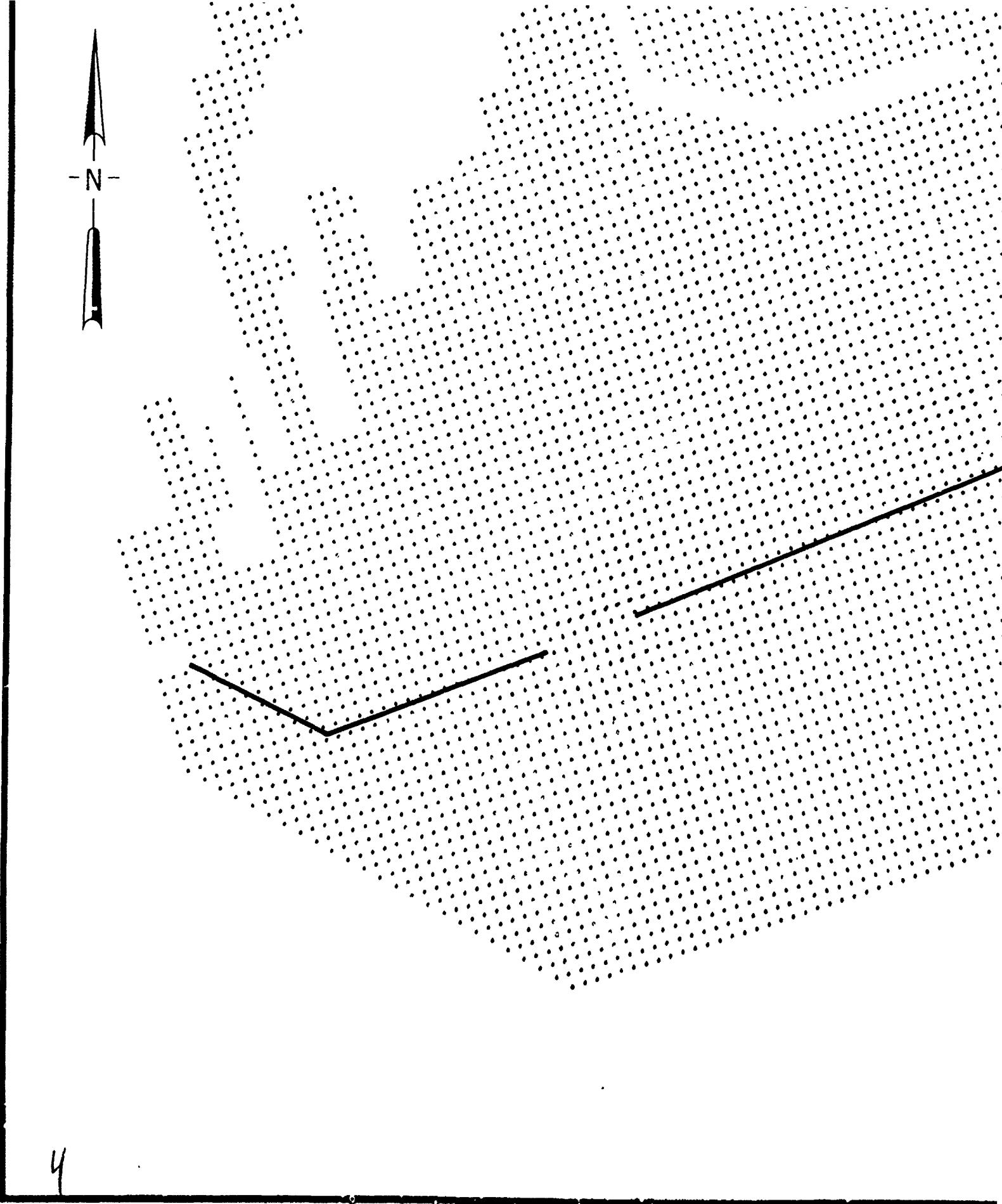
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VELOCITY SCALE
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PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,



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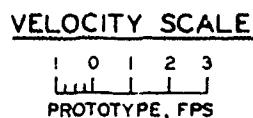
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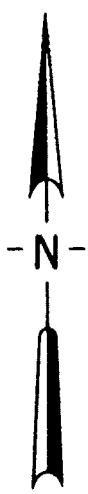


NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

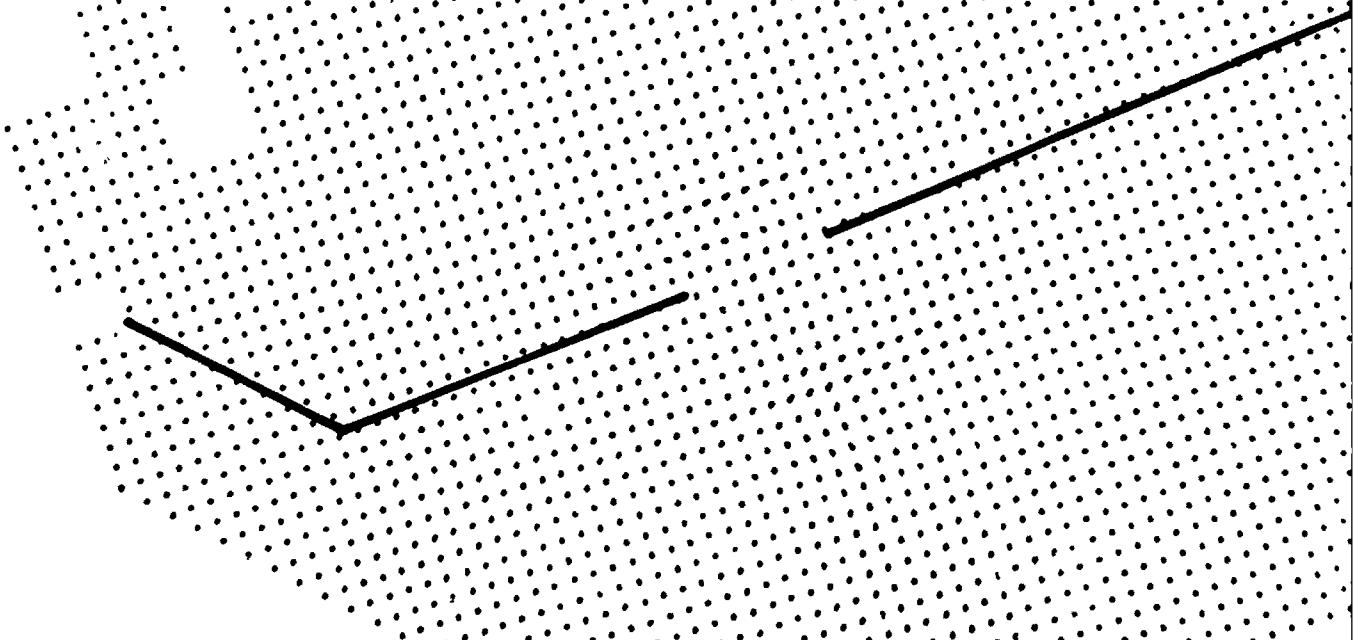
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 2,
-82-FT CHANNEL, 600-FT OPENING,
AND EXISTING CONDITIONS**

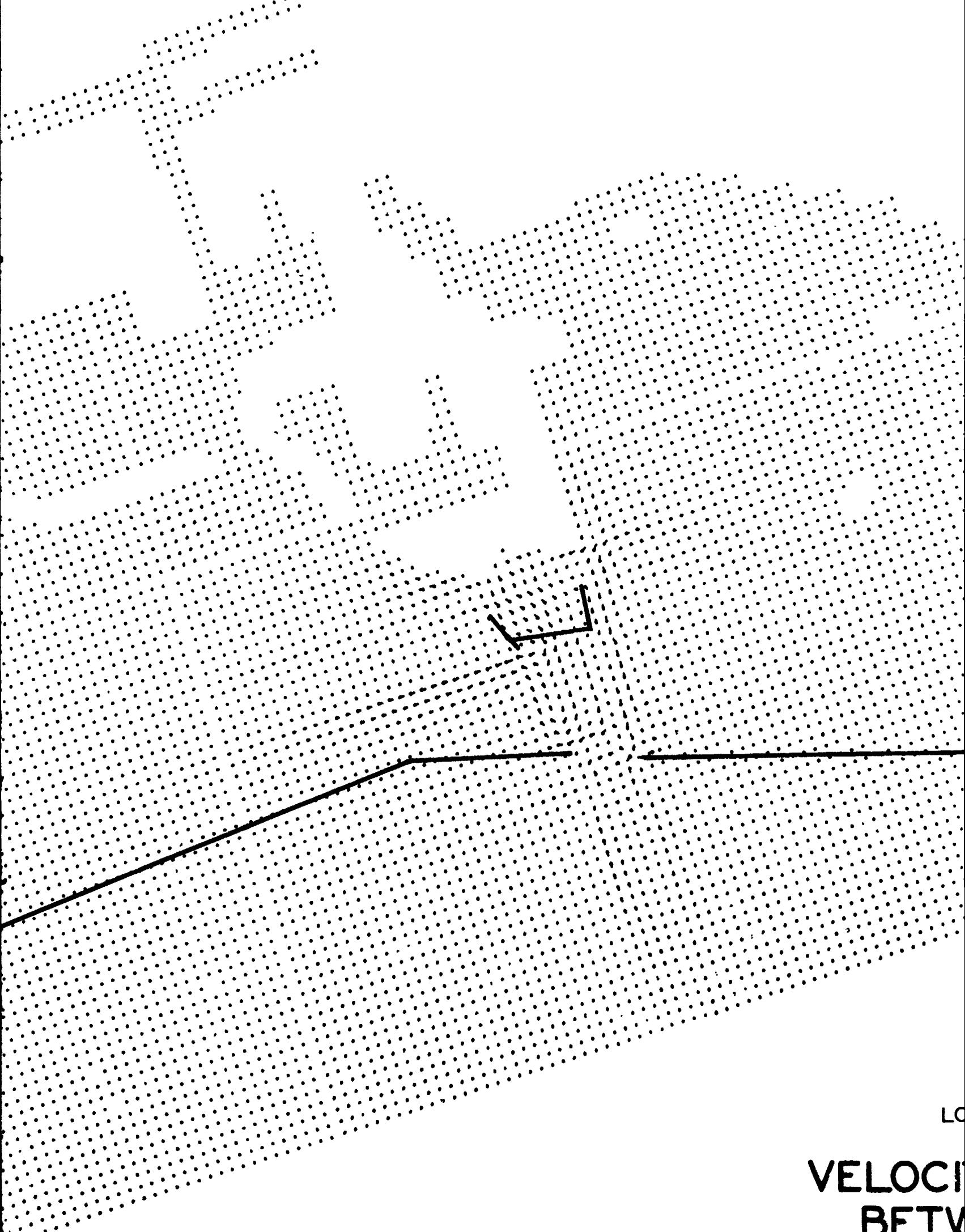
SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)

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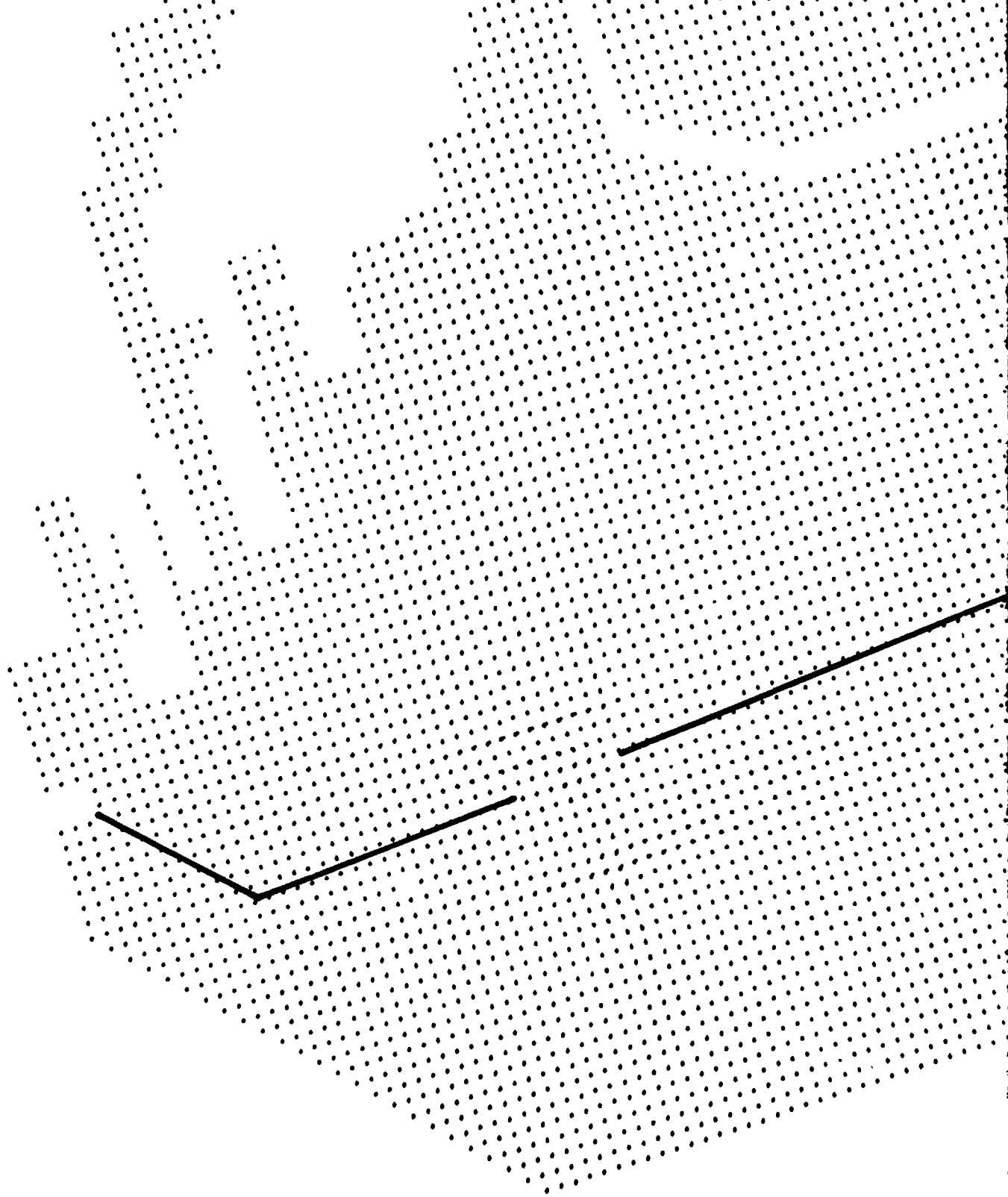
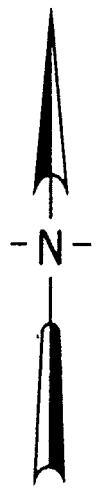




VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,



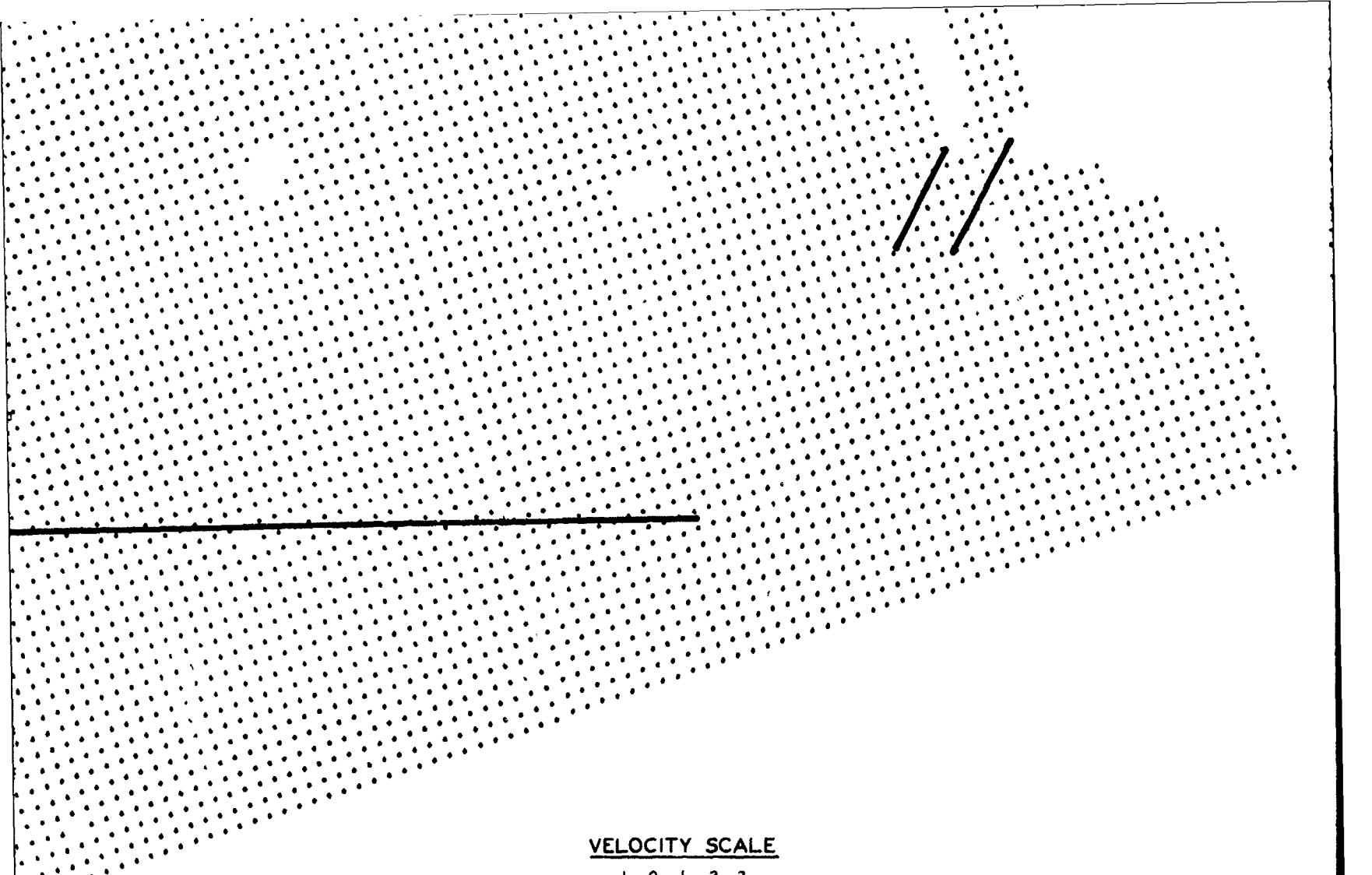
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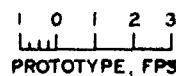
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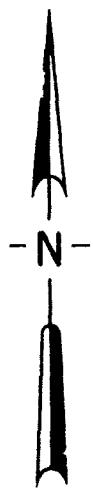
VELOCITY SCALE



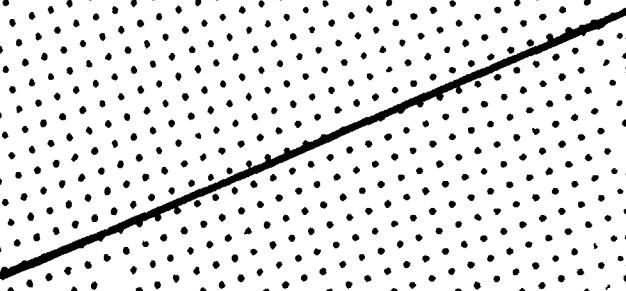
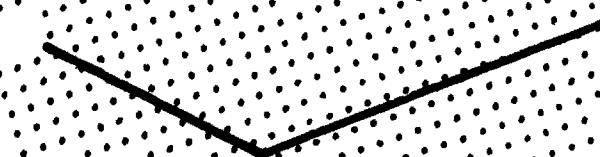
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

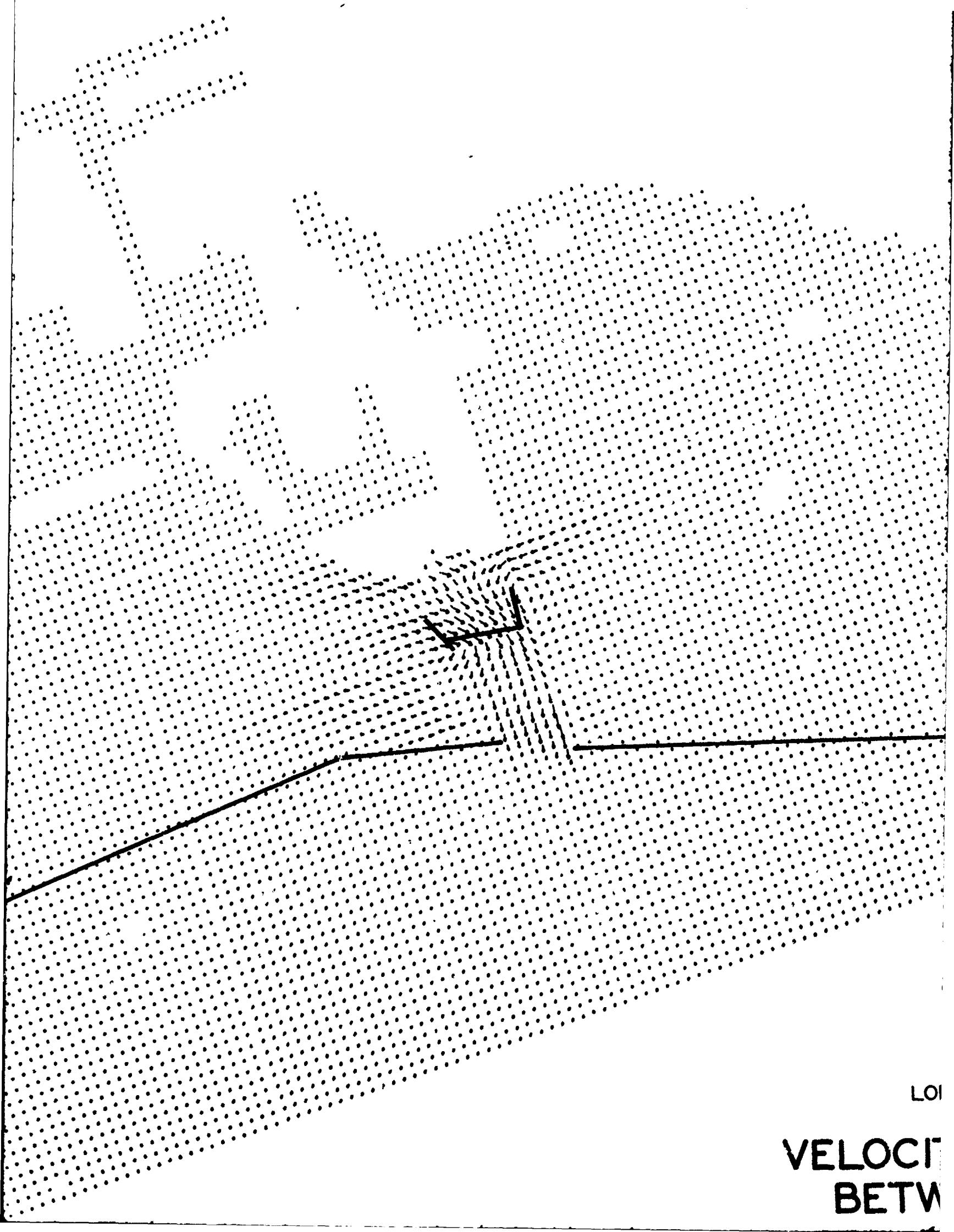
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,
-82-FT CHANNEL,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 15 (NEAR SLACK WATER)



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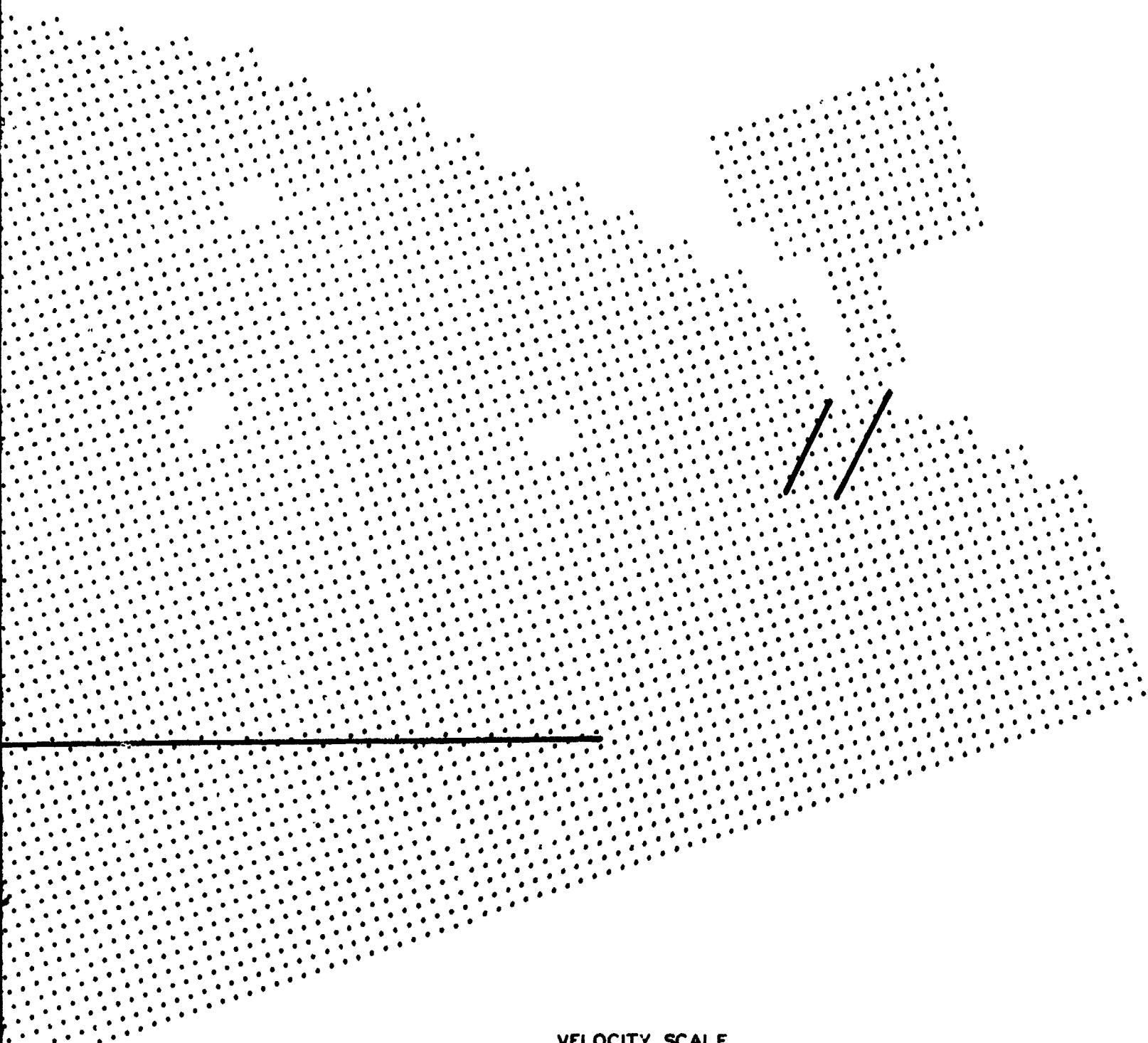




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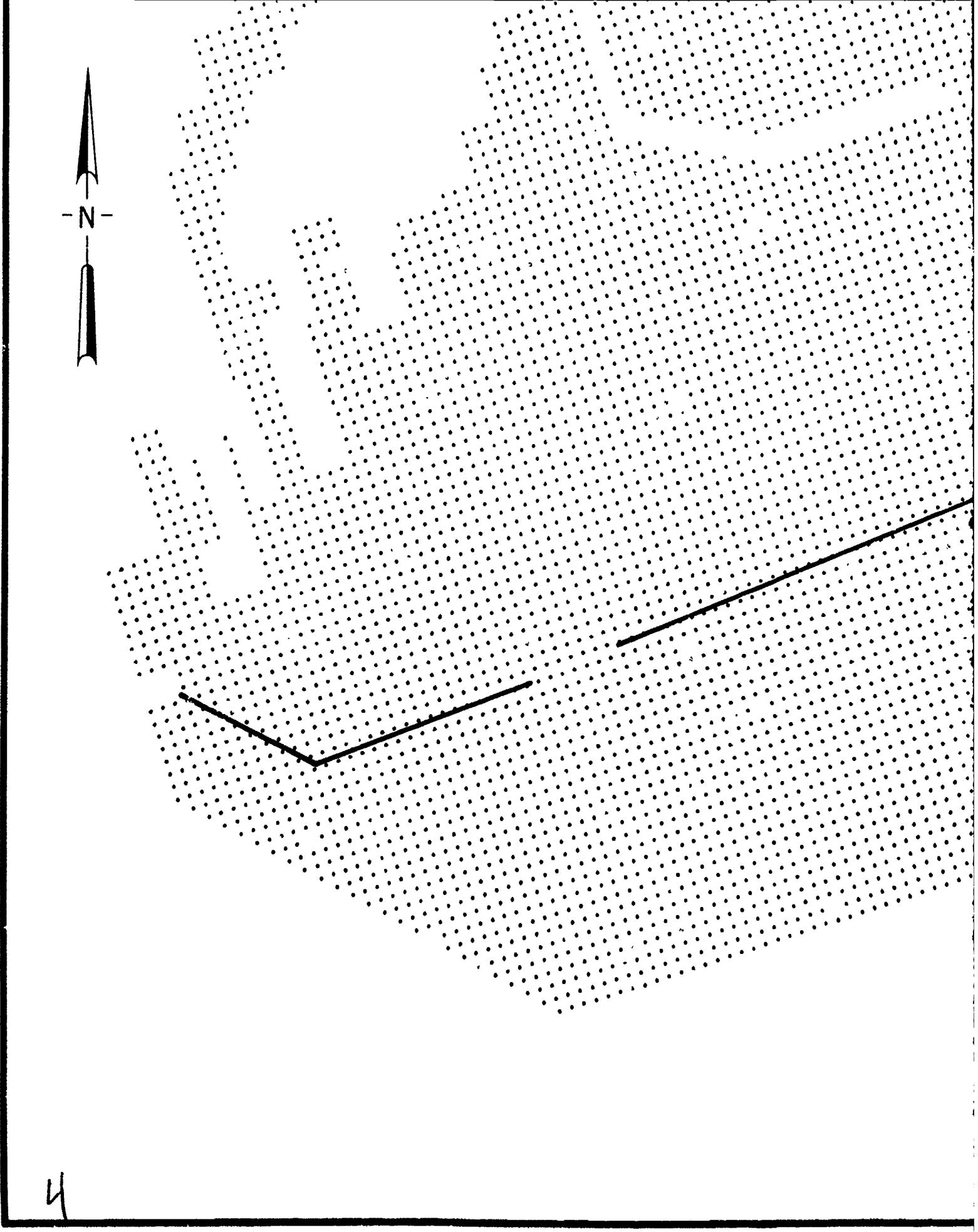
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VELOCITY SCALE
1 0 1 2 3
PROTOTYPE, FPS

NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STEP 3



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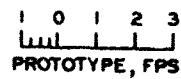
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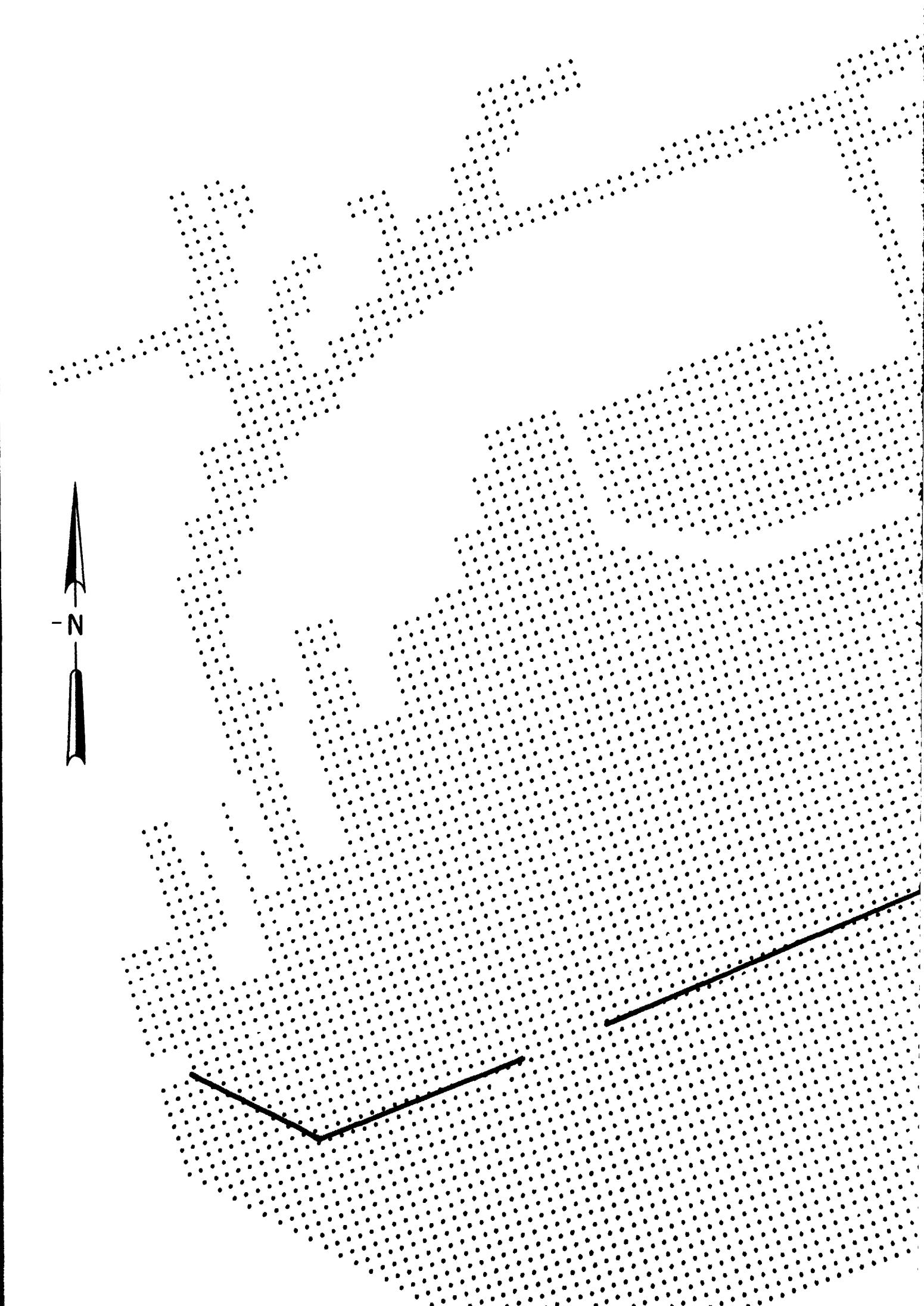
VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,
-82-FT CHANNEL,
AND EXISTING CONDITIONS**

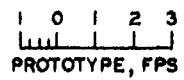
SPRING TIDE
HOUR 19 (NEAR MAXIMUM FLOOD)



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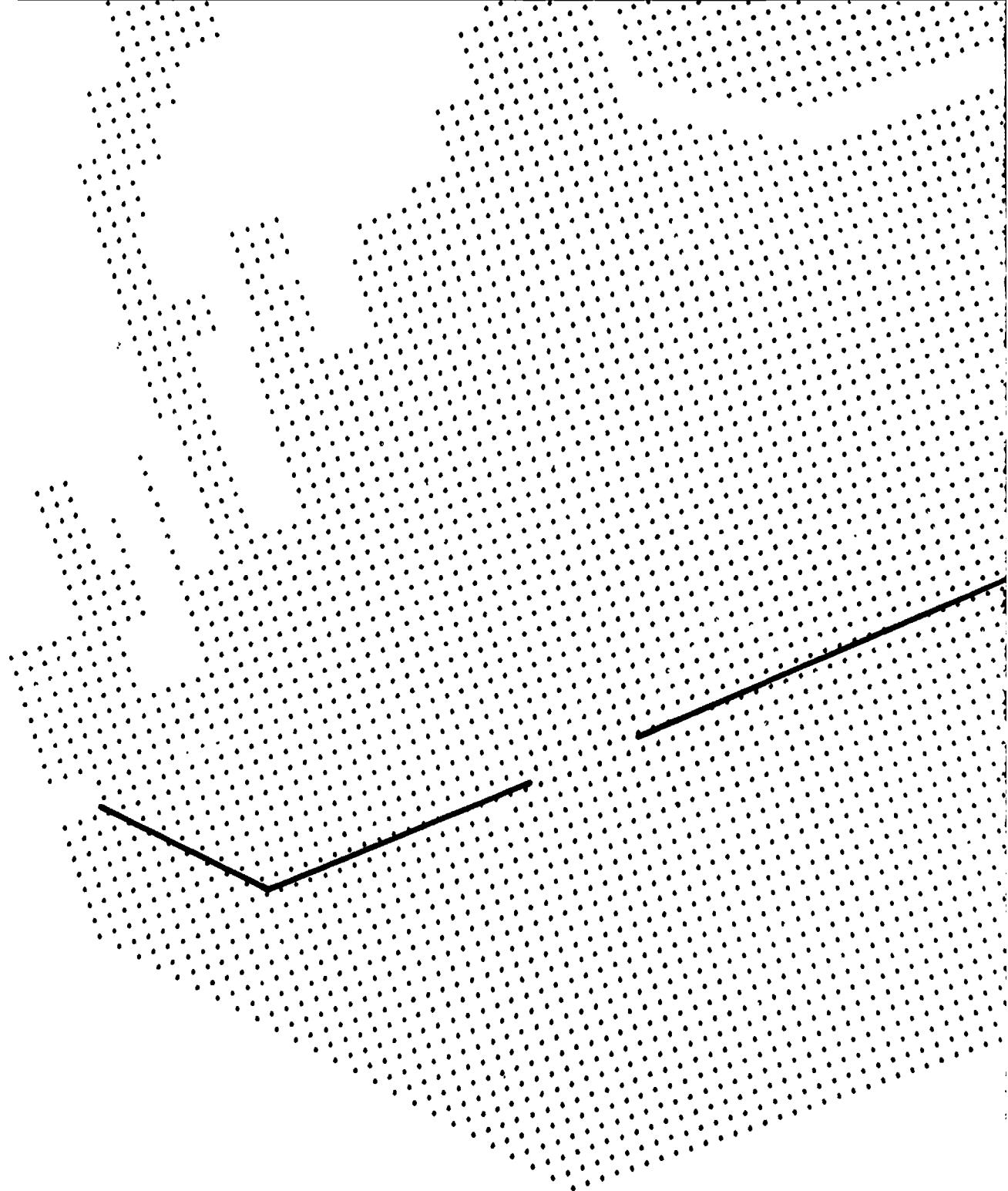
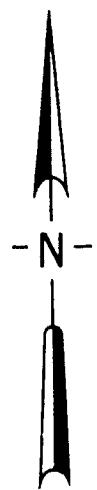


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,**



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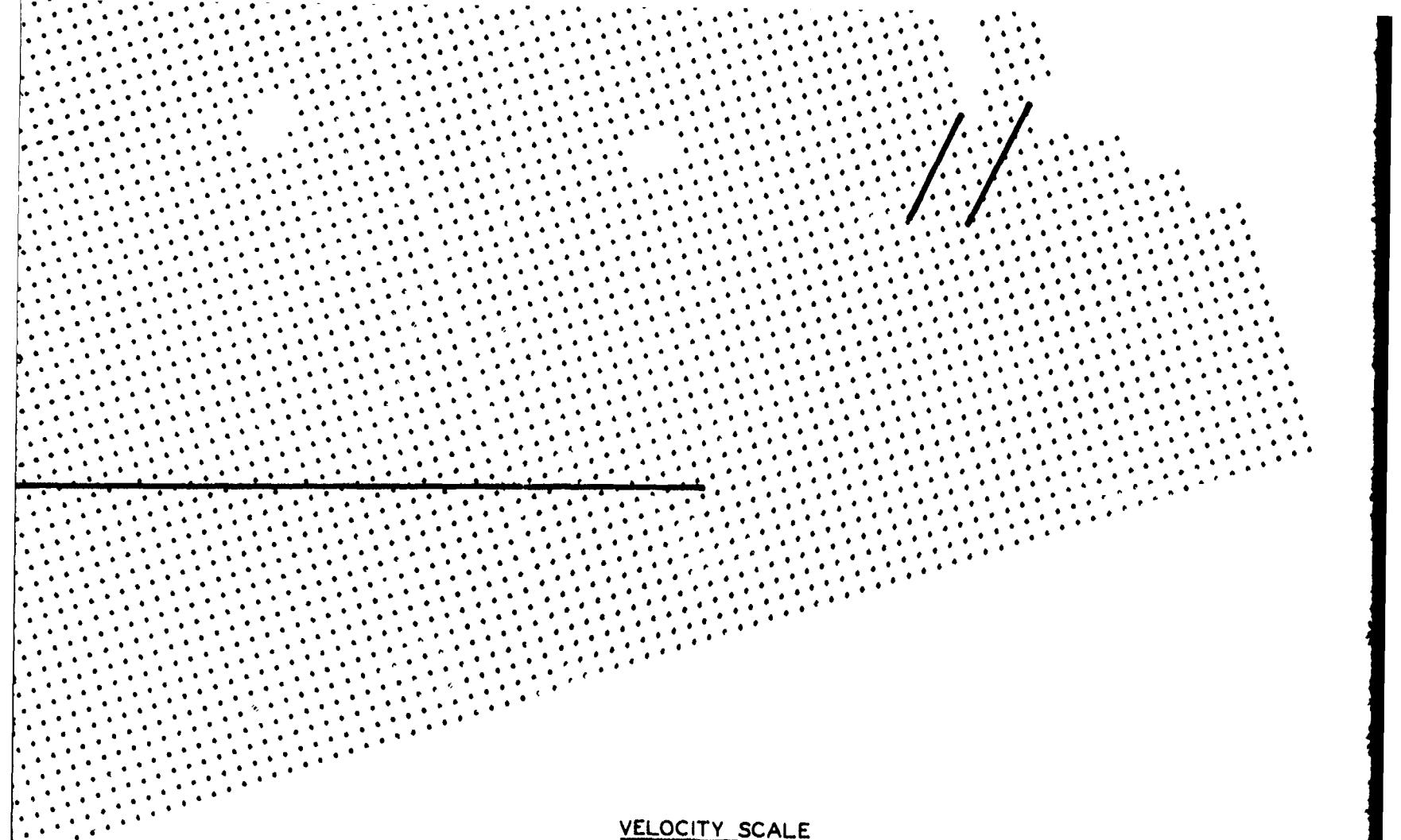
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VELOCITY SCALE

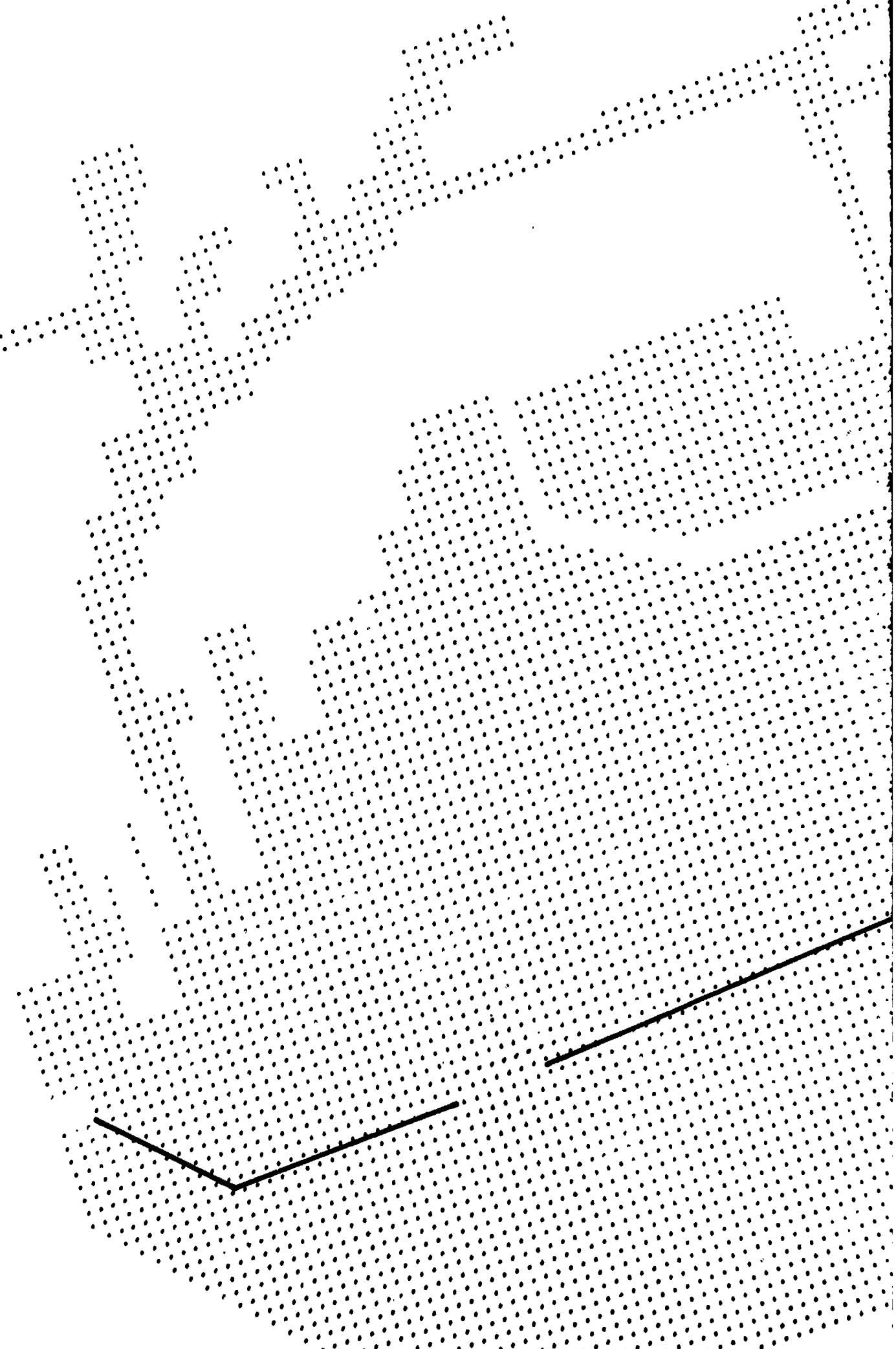


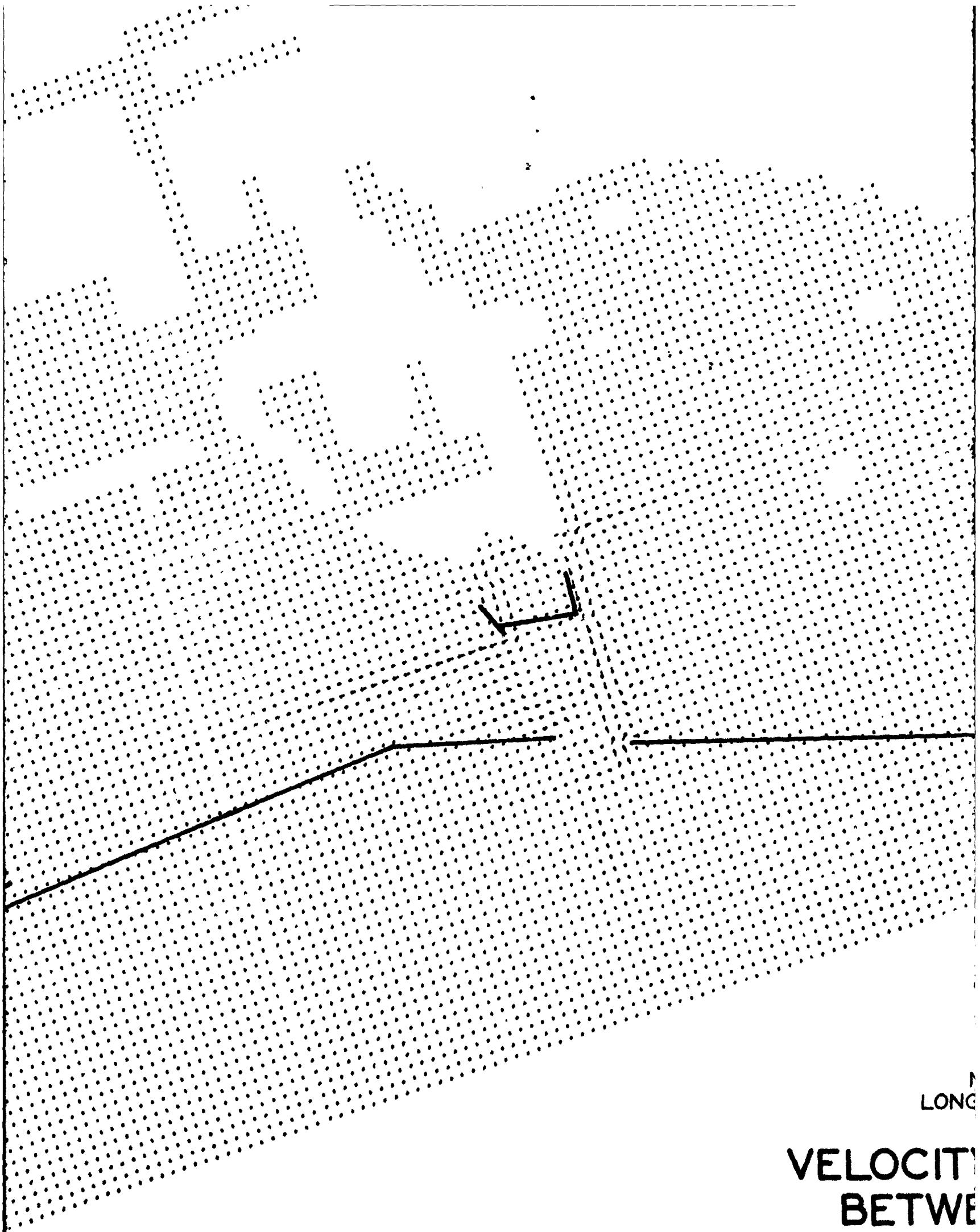
NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

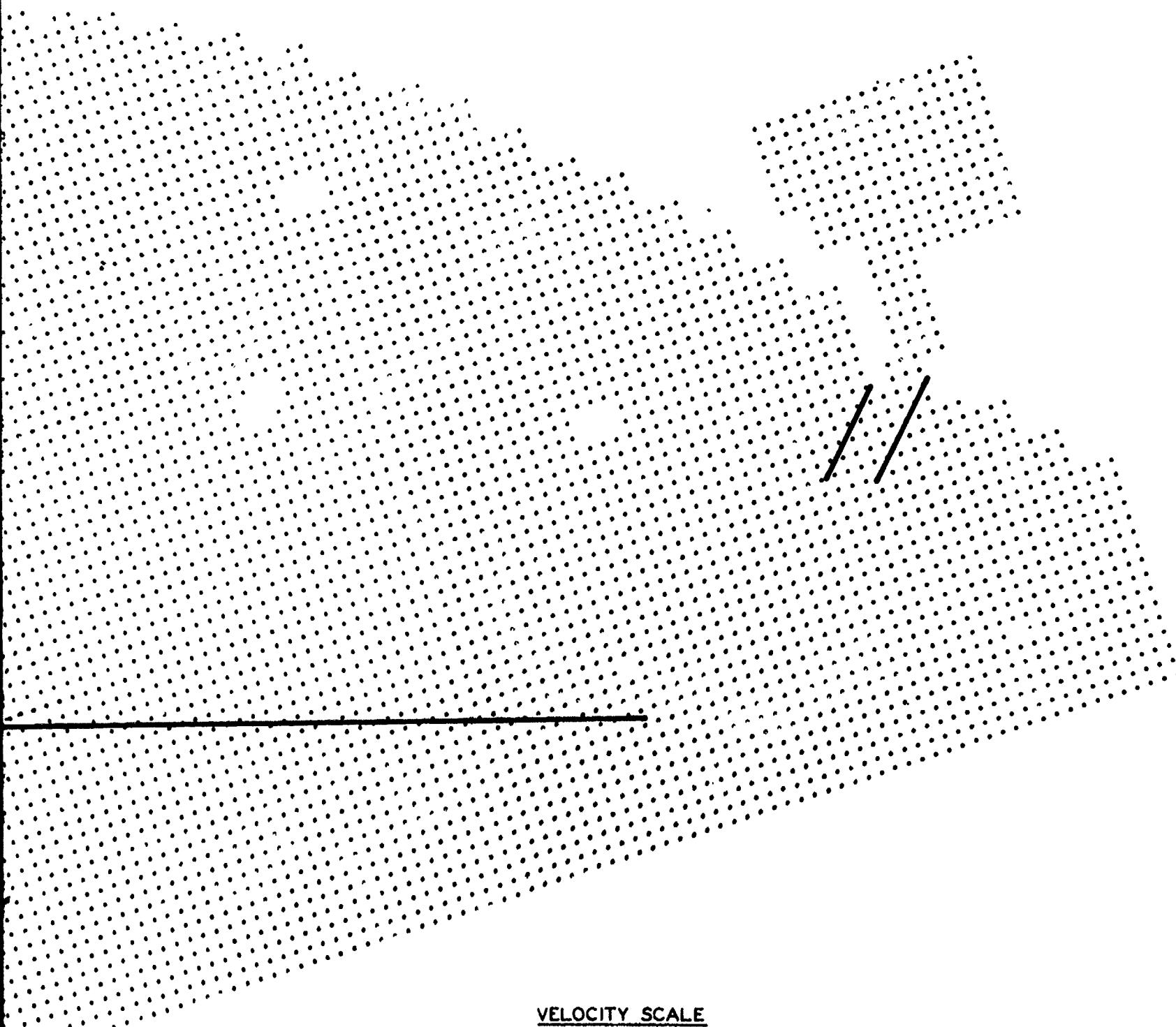
**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,
-82-FT CHANNEL,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 22 (NEAR SLACK WATER)

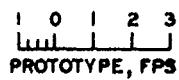
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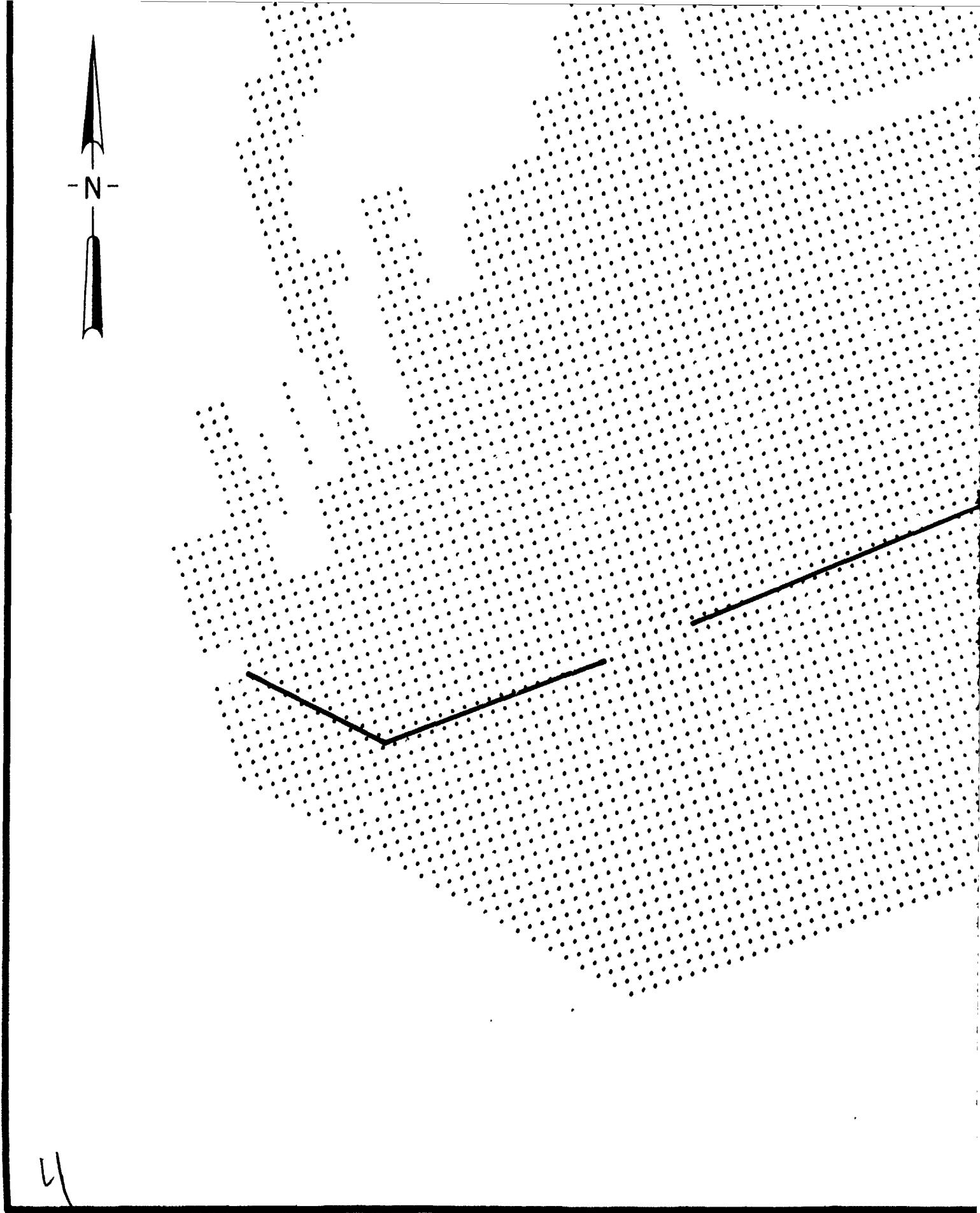


VELOCITY SCALE



NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,**



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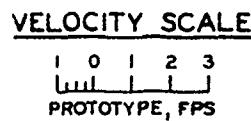
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NUMERICAL MODEL STUDY OF
LONG BEACH - LOS ANGELES HARBORS

**VELOCITY DIFFERENCE PATTERN
BETWEEN SCHEME STFP 3,
- 82 - FT CHANNEL,
AND EXISTING CONDITIONS**

SPRING TIDE
HOUR 24 (NEAR MAXIMUM EBB)